A Base-Promoted One-Pot Tandem Reaction of 3-(1-Alkynyl) chromones under Microwave Irradiation to Functionalized Amino-substituted Xanthones

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Supporting Information

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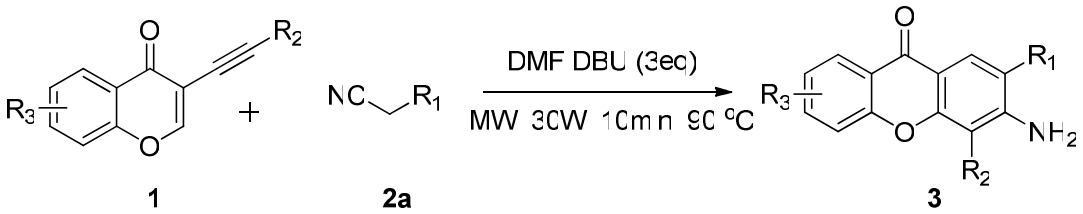
1. Experiment procedures

All reactions were performed in oven-dried microwave vials (10 mL) containing a Teflon-coated stirrer bar and a septum under an argon atmosphere. All microwave irradiation experiments were carried out in a CEM-Discover®LabMate mono-mode microwave apparatus equipped with an IntelliVent™ pressure control system and a vertically-focused IR temperature sensor. The reaction was monitored with CEM's ChemDriver™ software. After the irradiation period, the reaction vessel was cooled rapidly (60-120 sec) to ambient temperature by air jet cooling. Dry solvents were distilled prior to use: DMF was dried over microwave-dried molecular sieve; Petroleum ether refers to the fraction with boiling point in the range 60 – 90 °C. All ^{1}H NMR and ^{13}C NMR spectra were measured in $CDCl_3$ or d_6-DMSO with TMS as the internal standard. Chemical shifts are expressed in ppm and *J* values are given in Hz. Melting points are uncorrected.

General Procedure:

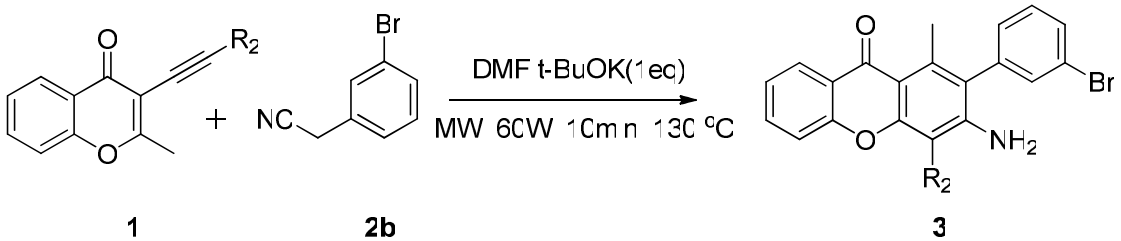
1.1 Tandem reaction of 3-(1-Alkynyl) chromones[1] and 2-phenylacetonitrile compounds to Functionalized Xanthones 3aa-af and 3bb-3bi



1 2a 3

A typical procedure for the preparation of **3aa**: To a solution of 2-phenylacetonitrile **2a** (0. 2 mmol) in dry DMF (1 mL) was added DBU (0.1 mL, 0.6 mmol) at room temperature under nitrogen atmosphere. After stirring for 5 min, compound **1a** (50 mg, 0.2 mmol) was added and the resulting dark red solution was irradiated for 10 min at 90 °C (monitored by TLC). The mixture was extracted with ethyl acetate (10 mL×3). The combined organic layers were washed with brine(10 mL), dried over anhydrous Na_2SO_4 , filtered and concentrated to give the crude product, which was further purified by column chromatography (petroleum ether/ethyl acetate 8:1) to afford compound **3aa** as a white solid (66 mg, 90%).

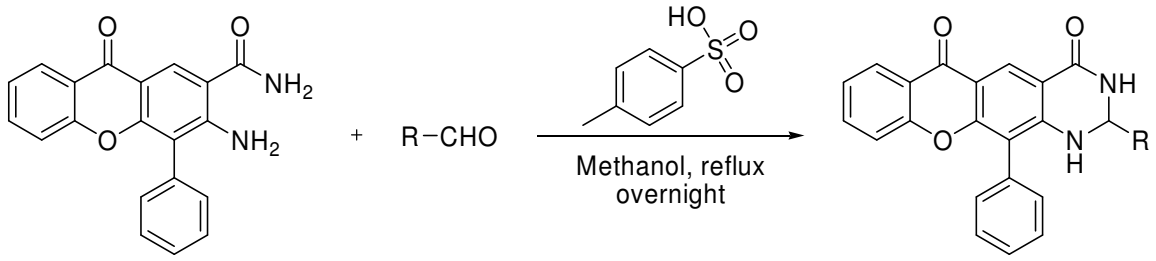
1.2 General Procedure of Tandem Reaction of 2-methyl-3-(1-Alkynyl) chromones and 2b to Amino-substituted Xanthones. 3bk-3bl



1 2b 3

A typical procedure for the preparation of **3bk**: To a solution of 2-(3-bromophenyl)acetonitrile **2b** (0.2 mmol) in dry DMF (1 mL) was added t-BuOK (23 mg, 0.2 mmol) at room temperature under nitrogen atmosphere. After stirring for 5 min, compound **1k** (52 mg, 0.2 mmol) was added and the resulting dark red solution was irradiated for 15 min at 150 °C (monitored by TLC). The mixture was extracted with ethyl acetate (10 mL×3). The combined organic layers were washed with brine(10 mL), dried over anhydrous Na_2SO_4 , filtered and concentrated to give the crude product, which was further purified by column chromatography (petroleum ether/ethyl acetate 6:1) to afford compound **3bk** as a yellow solid (67 mg, 74%).

1.3 General Procedure of Synthetic application for 3ae.

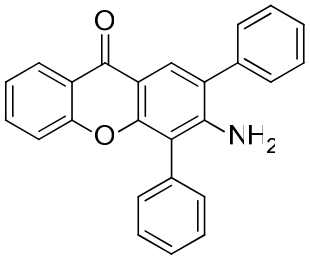


A typical procedure for the preparation of **4a**: **3ae** (66mg, 0.2 mmol) and benzaldehyde (22 mg, 0.2 mmol) were suspended in methanol (10 mL) and refluxed in the presence of catalytic amounts of p-toluenesulfonic acid (4 mg, 10%) overnight. After the reaction mixture was filtered and washed with cold methanol, **4a** was obtained as a light-brown solid (72 mg, 85%).

1. Pal, M.; Subramanian, V.; Parasuraman, K.; Yeleswarapu, K. R. *Tetrahedron.* **2003,** *59*, 9563.

2. Characterization Data:

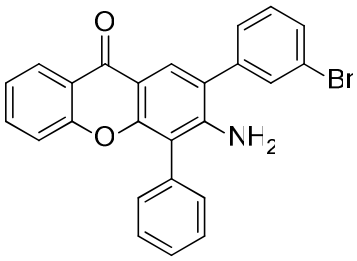
2.1 3aa-af



3-amino-2,4-diphenyl-9H-xanthen-9-one (3aa)

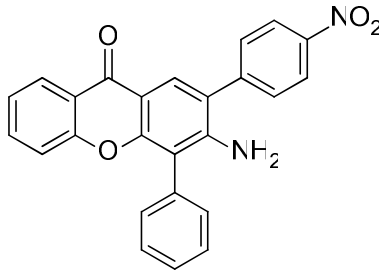
Following the general procedure, from 50 mg (0.2 mmol) of **1a,** 66 mg (90%) of **3aa** as a white solid was obtained: m.p. 157-158 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.31 (dd, *J* = 1.7, 8.0 Hz, 1H), 8.15 (s, 1H), 7.4-7.6 (m, 11H), 7.31 (t, *J* = 7.0 Hz, 1H), 7.18 (d, *J* = 8.3 Hz 1H), 4.40 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ: 176.3, 156.0, 154.2, 148.0, 137.9, 133.6, 133.1, 130.7, 129.3, 129.2, 129.1, 128.1, 127.9, 127.6, 126.4, 125.1, 123.5, 121.8, 117.7, 113.3, 112.9. HRMS $[M]^+$ Calculated for $C_{25}H_{17}NO_2$ 363.1259, found

363.1264.



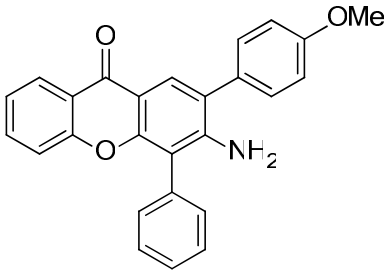
3-amino-2-(3-bromophenyl)-4-phenyl-9H-xanthen-9-one (3ab)

Following the general procedure, from 50 mg (0.2 mmol) of **1a,** 84 mg (95%) of **3ab** as a white solid was obtained: m.p. 147-148 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.31 (d, *J* = 7.7 Hz, 1H), 8.12 (s, 1H), 7 .70 (s, 1H), 7.46-7.60 (m, 8H), 7.29-7.40 (m, 2H), 7.18 (d, *J* = 8.5 Hz, 1H), 4.36 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 176.2, 156.0, 154.4, 147.7, 140.0, 133.8, 132.8, 133.3, 131.0, 130.7, 130.6, 129.3, 128.3, 127.9, 127.7, 126.4, 123.6, 123.5, 123.1, 121.7, 117.8, 113.4, 113.2; HRMS $[M]^+$ Calculated for $C_{25}H_{16}BrNO_2$ 441.0364, found 441.0377.



3-amino-2-(4-nitrophenyl)-4-phenyl-9H-xanthen-9-one (3ac)

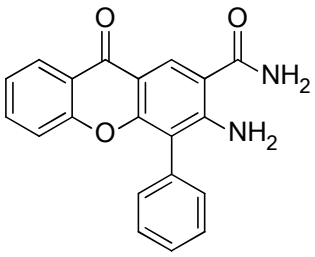
Following the general procedure, from 50 mg (0.2 mmol) of **1a,** 71 mg (87%) of **3ac** as a light yellow solid was obtained: m.p. 282-283 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.37 (d, *J* = 8.8 Hz, 2H), 8.31 (d, *J* = 7.9 Hz, 1H), 8.16 (s, 1H), 7.75 (d, *J* = 8.8 Hz, 2H), 7.57-7.62 (m, 3H), 7.46-7.53 (m, 3H), 7.33 (t, *J* = 7.1 Hz, 1H), 7.19 (d, *J* = 8.6 Hz, 1H), 7.14 (s, 1H), 4.35 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.1, 156.0, 157.4, 147.4, 147.3, 144.9, 134.0, 132.5, 130.6, 130.2, 129.4, 128.4, 127.9, 126.4, 124.3, 123.8, 122.6, 121.6, 117.8, 113.8, 113.7; HRMS $[M]^+$ Calculated for $C_{25}H_{16}N_2O_4$ 408.1110, found 408.1114.



3-amino-2-(4-methoxyphenyl)-4-phenyl-9H-xanthen-9-one (3ad)

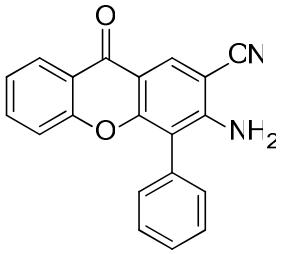
Following the general procedure, from 50 mg (0.2 mmol) of **1a,** 55 mg (69%) of **3ad** as a white solid was obtained: m.p. 218-219 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.30 (d, *J* = 8.0 Hz, 2H), 8.10 (s, 1H), 7.50-7.59 (m, 3H), 7.49-7.41 (m, 5H), 7.29 (t, *J* = 8.1 Hz, 1H), 7.16 (d, *J* = 8.1 Hz, 1H), 6.99 (d, *J* = 8.8 Hz, 2H) 4.41 (s, 1H), 3.84 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.3, 159.2, 156.0, 154.0, 148.2,

133.6, 133.1, 130.7, 130.4, 130.0, 129.2, 128.1, 127.4, 126.3, 124.8, 123.4, 121.7, 117.7, 114.4, 113.2, 112.8; HRMS $[M]^+$ Calculated for $C_{26}H_{19}NO_3$ 393.1365, found 393.1346.



3-amino-9-oxo-4-phenyl-9H-xanthene-2-carboxamide (3ae)

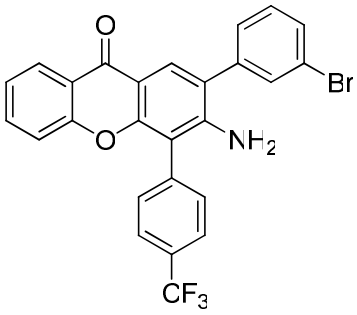
Following the general procedure, from 50 mg (0.2 mmol) of **1a,** 57 mg (86%) of **3ae** as a light brown solid was obtained: m.p. 274-275 ^oC; ^1H NMR (300 MHz, d_6-DMSO) δ 8.53 (s, 1H), 8.34 (s, 1H), 8.13 (d, J = 8.0 Hz, 1H), 7.68 (t, J = 8.0 Hz, 3H), 7.59 (t, J = 7.4 Hz, 2H), 7.50 (t, J = 7.4 Hz, 1H), 7.36-7.45 (m, 4H), 7.15 (d, J = 8.3 Hz, 1H), 6.90 (s, 2H); ^{13}C NMR (100 MHz, d_6-DMSO) δ 174.5, 170.5, 155.3, 154.9, 152.6, 134.7, 132.0, 130.7, 129.2, 128.1, 127.9, 125.8, 124.1, 121.0, 117.6, 113.3, 112.7, 110.4; HRMS $[M]^+$ Calculated for $C_{20}H_{14}N_2O_3$ 330.1004, found 330.1008.



3-amino-9-oxo-4-phenyl-9H-xanthene-2-carbonitrile (3af)

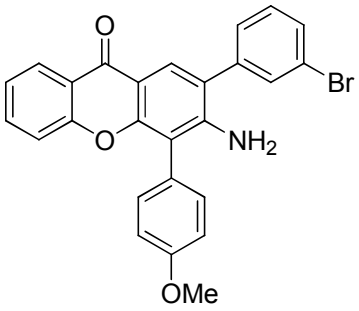
Following the general procedure, from 50 mg (0.2 mmol) of **1a,** 55 mg (88%) of **3af** as a light yellow solid was obtained: m.p. 238-239 ^oC; ^1H NMR (300 MHz, $CDCl_3$) δ 8.53 (s, 1H), 8.27 (d, J = 8.1 Hz, 1H), 7.57-7.63 (m, 3H), 7.53 (t, J = 7.4 Hz, 1H), 7.40-7.42 (m, 2H), 7.34 (t, J = 8.0 Hz, 1H), 7.16 (d, J = 8.0 Hz, 1H), 4.89 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 175.1, 156.4, 155.8, 151.1, 134.7, 132.7, 130.9, 129.6, 128.9, 126.6, 124.4, 121.2, 117.9, 116.5, 113.9, 113.7, 94.5; HRMS $[M]^+$ Calculated for $C_{20}H_{12}N_2O_2$ 312.0899, found 312.0898.

2.2 3bb-bj



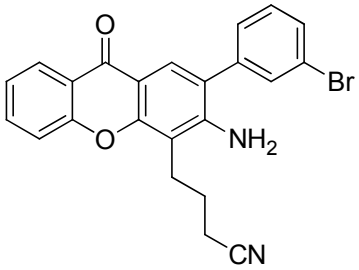
3-amino-2-(3-bromophenyl)-4-(4-(trifluoromethyl) phenyl)-9H-xanthen-9-one (3bb)

Following the general procedure, from 63 mg (0.2 mmol) of **1b,** 92 mg (90%) of **3bb** as a white solid was obtained: m.p. 189-190 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.31 (dd, *J* = 1.4 , 8.2 Hz, 1H), 8.14 (s, 1H), 7.85 (d, *J* = 7.9 Hz, 2H), 7.69 (s, 1H), 7.63 (d, *J* = 7.9 Hz, 2H), 7.54-7.60 (m, 2H), 7.43-7.49 (m, 1H), 7.39 (t, *J* = 8.1 Hz, 1H), 7.33 (t, *J* = 8.1 Hz, 1H), 7.18 (d, *J* = 8.5 Hz, 1H), 4.33 (s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.0, 155.9, 154.2, 147.4, 139.6, 136.9, 134.0, 132.3, 131.3, 131.2, 130.7, 130.6, 128.3, 127.9, 126.4, 126.3, 126.2, 123.8, 123.7, 123.2, 121.7, 117.7, 113.4, 111.7; HRMS $[M]^+$ Calculated for $C_{26}H_{15}BrF_3NO_2$ 509.0238, found 509.0233.



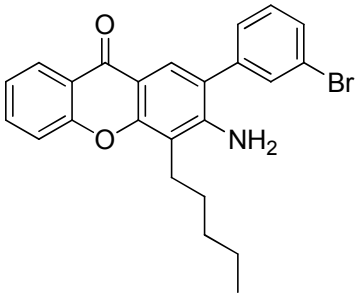
3-amino-2-(3-bromophenyl)-4-(4-methoxyphenyl)-9H-xanthen-9-one (3bc)

Following the general procedure, from 56 mg (0.2 mmol) of **1c,** 81 mg (86%) of **3bc** as a white solid was obtained: m.p. 233-234 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.31 (d, *J* = 8.3 Hz, 1H), 8.10 (s, 1H), 7.70 (s, 1H), 7.51-7.62 (m, 2H), 7.47 (d, *J* = 7.6 Hz, 1H), 7.35-7.42 (m, 3H), 7.31 (t, *J* = 8.0 Hz, 1H), 7.21 (d, *J* = 8.0 Hz, 1H), 7.11 (d, *J* = 8.5 Hz, 2H), 4.37 (s, 2H), 3.92 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.3, 159.4, 156.0, 154.5, 148.0, 140.0, 133.7, 132.3, 131.8, 130.9, 130.6, 127.9, 127.5, 126.4, 124.6, 123.5, 123.4, 123.1, 121.7, 117.8, 114.7, 113.4, 112.9, 55.3; HRMS $[M]^+$ Calculated for $C_{26}H_{18}BrNO_3$ 471.0470, found 471.0474.



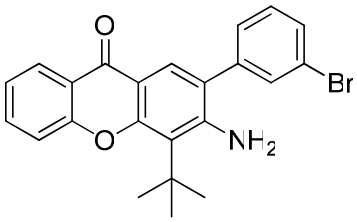
4-(3-amino-2-(3-bromophenyl)-9-oxo-9H-xanthen-4-yl) butanenitrile (3bd)

Following the general procedure, from 48 mg (0.2 mmol) of **1d,** 72 mg (83%) of **3bd** as a white solid was obtained: m.p. 150-151 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.32 (dd, *J* = 1.6, 7.8 Hz, 1H), 8.02 (s, 1H), 7.70 (td, *J* = 7.0 , 1.8 Hz, 1H), 7.53-7.65 (m, 3H), 7.33-7.43 (m, 3H), 4.47 (s, 2H), 3.09 (t, *J* = 7.2 Hz, 2H), 2.49 (t, *J* = 7.0 Hz, 1H), 2.08 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.1, 155.8, 155.1, 147.7, 139.8, 134.1, 132.2, 131.0 130.6, 127.9, 126.8, 123.8, 123.1, 121.5, 119.8, 117.7, 113.3, 109.0, 23.6, 22.5, 17.0; HRMS $[M]^+$ Calculated for $C_{23}H_{17}BrN_2O_2$ 432.0473, found 432.0491.



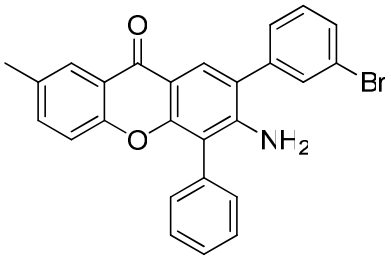
3-amino-2-(3-bromophenyl)-4-pentyl-9H-xanthen-9-one (3be)

Following the general procedure, from 49 mg (0.2 mmol) of **1e,** 81 mg (92%) of **3be** as a white solid was obtained: m.p. 140-141 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.32 (dd, *J* = 1.6 , 8.1 Hz, 1H), 7.98 (s, 1H), 7.64-7.72 (m, 2H), 7.54 (dt, *J* = 1.7 , 7.7 Hz, 1H), 7.49 (d, *J* = 7.7 Hz, 1H), 7.42 (dt, *J* = 1.7 , 7.7 Hz, 1H), 7.35 (t, *J* = 7.7 Hz, 1H), 4.41 (s, 2H), 2.87 (t, *J* = 7.9 Hz, 2H), 1.61-1.75 (m, 2H), 1.37-1.53 (m, 4H), 0.94 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.4, 156.0, 155.0, 147.5, 140.2, 133.8, 132.3, 130.8 130.5, 128.0, 126.5, 126.0, 123.7, 123.5, 123.0, 121.7, 117.6, 113.4, 112.1, 31.9, 27.4, 23.9, 22.5, 14.0; HRMS $[M]^+$ Calculated for $C_{24}H_{22}BrNO_2$ 435.0834, found 435.0833.



3-amino-2-(3-bromophenyl)-4-(tert-butyl)-9H-xanthen-9-one (3bf)

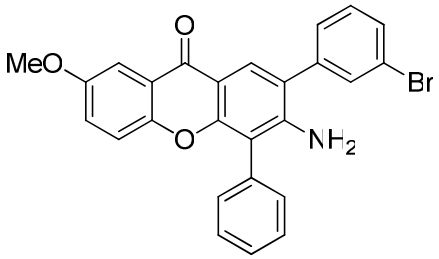
Following the general procedure, from 46 mg (0.2 mmol) of **1f,** 55 mg (65%) of **3bf** as a white solid was obtained: m.p. 135-136 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.30 (dd, *J* = 1.8 , 8.1 Hz, 1H), 7.97 (s, 1H), 7.68 (td, *J* = 7.4 , 1.7 Hz, 1H), 7.61 (s, 1H), 7.54 (dt, *J* = 7.4 , 1.7 Hz, 1H), 7.47 (d, *J* = 8.1 Hz, 1H), 7.30-7.40 (m, 3H), 4.78 (s, 2H), 1.76 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.3, 156.3, 155.4, 148.6, 140.6, 133.8, 132.8, 130.9 130.5, 128.5, 126.5, 126.2, 125.8, 123.5, 123.0, 121.2, 117.3, 116.9, 114.0, 36.6, 32.0; HRMS $[M]^+$ Calculated for $C_{23}H_{20}BrNO_2Na$ 444.0575, found 444.0564.



3-amino-2-(3-bromophenyl)-7-methyl-4-phenyl-9H-xanthen-9-one (3bg)

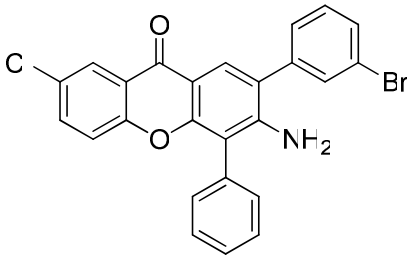
Following the general procedure, from 53 mg (0.2 mmol) of **1g,** 88 mg (96%) of **3bg** as a white solid was obtained: m.p. 184-185 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.14 (s, 1H), 8.11 (s, 1H), 7.72 (s, 1H), 7.46-7.63 (m, 7H), 7.35-7.43 (m, 2H), 7.11 (d, *J* = 8.5 Hz, 1H), 4.34 (s, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.3, 154.4, 154.2, 147.5, 140.0, 135.0, 133.3, 132.9, 132.3, 130.9, 130.7, 130.6, 129.3,

128.2, 127.9, 127.7, 125.8, 123.4, 123.1, 121.3, 117.5, 113.4, 113.1, 20.8; HRMS $[M]^+$ Calculated for $C_{26}H_{18}BrNO_2$ 455.0521, found 455.0531.



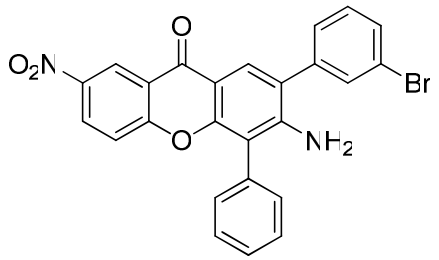
3-amino-2-(3-bromophenyl)-7-methoxy-4-phenyl-9H-xanthen-9-one (3bh)

Following the general procedure, from 56 mg (0.2 mmol) of **1h,** 87 mg (92%) of **3bh** as a white solid was obtained: m.p. 166-167 ^oC; ^1H NMR (300 MHz, $CDCl_3$) δ 8.12 (s, 1H), 7.67-7.72 (m, 2H), 7.52-7.62 (m, 3H), 7.43-7.52 (m, 4H), 7.37 (t, *J* = 7.7 Hz, 1H), 7.16 (s, 1H), 7.15 (d, *J* = 7.7 Hz, 1H), 4.34 (s, 1H), 3.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 176.0, 155.7, 154.3, 150.7, 147.5, 140.0, 132.8, 132.3, 130.9, 130.7, 130.6, 129.2, 128.2, 127.9, 127.6, 123.6, 123.1, 121.9, 119.2, 113.0, 112.9, 105.6, 55.8; HRMS $[M]^+$ Calculated for $C_{26}H_{18}BrNO_3$ 471.0470, found 471.0480.



3-amino-2-(3-bromophenyl)-7-chloro-4-phenyl-9H-xanthen-9-one (3bi)

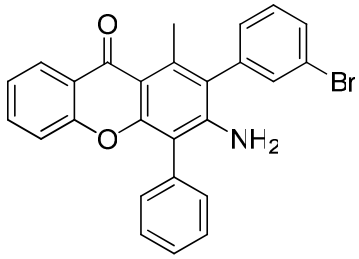
Following the general procedure, from 57 mg (0.2 mmol) of **1i,** 89 mg (94%) of **3bi** as a white solid was obtained: m.p. 195-196 ^oC; ^1H NMR (300 MHz, $CDCl_3$) δ 8.27 (d, *J* = 2.7 Hz, 1H), 8.10 (s, 1H), 7.67-7.70 (m, 1H), 7.42-7.62 (m, 8H), 7.37 (t, *J* = 8.0 Hz, 1H), 7.14 (d, *J* = 8.8 Hz, 1H), 4.40 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 175.0, 154.3, 154.2, 148.1, 139.7, 133.8, 132.5, 132.2, 131.1, 130.7, 130.6, 129.4, 129.3, 128.4, 127.9, 127.7, 125.7, 123.8, 122.6, 119.5, 113.2, 112.9; HRMS $[M]^+$ Calculated for $C_{25}H_{15}BrClNO_2$ 474.9975, found 474.9974.



3-amino-2-(3-bromophenyl)-7-nitro-4-phenyl-9H-xanthen-9-one (3bj)

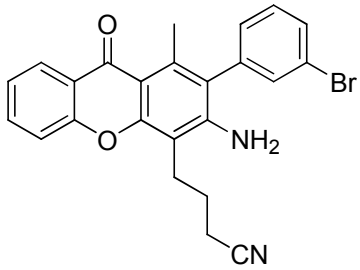
Following the general procedure, from 60 mg (0.2 mmol) of **1j,** 64 mg (66%) of **3bj** as a yellow solid was obtained: m.p. 266-267 ^oC; ^1H NMR (300 MHz, $CDCl_3$) δ 9.19 (d, *J* = 2.7 Hz, 1H), 8.40 (dd, *J* = 2.7 , 8.9 Hz, 1H), 8.12 (s, 1H), 7.67-7.70 (m, 1H), 7.50-7.64 (m, 3H), 7.43-7.49 (m, 4H), 7.37 (t, *J* = 7.7 Hz, 1H),

7.30 (d, J = 9.2 Hz, 1H), 4.50 (s, 2H); ^{13}C NMR (100 MHz, d_6-DMSO) δ 173.0, 158.5, 153.5, 149.9, 143.0, 139.8, 131.9, 131.6, 131.2, 130.8, 130.6, 129.3, 128.4, 128.3, 128.1, 126.9, 123.9, 122.3, 121.6, 120.9, 119.7, 112.4, 110.9; HRMS $[M]^+$ Calculated for $C_{25}H_{15}BrN_2O_4$ 486.0215, found 486.0217.



3-amino-2-(3-bromophenyl)-1-methyl-4-phenyl-9H-xanthen-9-one (3bk)

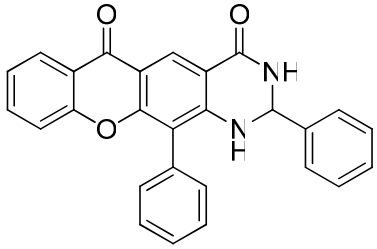
Following the general procedure, from 52 mg (0.2 mmol) of **1k,** 67 mg (74%) of **3bk** as a yellow solid was obtained: m.p. 165-166 °C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.25 (dd, J = 1.4, 8.0 Hz, 1H), 7.4-7.6 (m, 9H), 7.29 (d, J = 8.0 Hz, 1H), 7.24 (d, J = 7.8 Hz 1H), 7.09 (d, J = 7.8 Hz 1H), 3.97 (s, 2H), 2.64 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 178.0, 155.5, 154.9, 147.4, 140.3, 139.6, 133.4, 133.3, 131.1, 130.8, 130.4, 129.5, 129.2, 129.1, 128.0, 127.9, 126.5, 123.8, 123.5, 123.4, 122.9, 117.1, 20.4; HRMS $[M]^+$ Calculated for $C_{26}H_{18}BrNO_2$ 455.0521, found 455.0511.



4-(3-amino-2-(3-bromophenyl)-1-methyl-9-oxo-9H-xanthen-4-yl)butanenitrile (3bl)

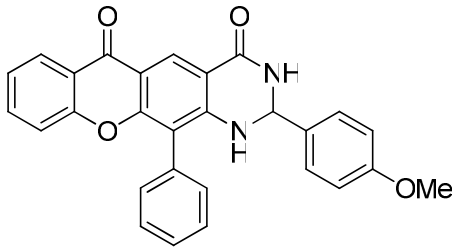
Following the general procedure, from 53 mg (0.2 mmol) of **1l,** 54 mg (60%) of **3bl** as a white solid was obtained: m.p. 143-144 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 8.26 (dd, J = 7.8 , 1.5 Hz, 1H), 7.66 (td, J = 8.3 , 1.5 Hz, 1H), 7.59 (d, J = 8.3 Hz, 1H), 7.52 (d, J = 8.2 Hz, 1H), 7.37-7.44 (m, 2 H), 7.34 (t, J = 7.2 Hz, 1H), 7.18 (d, J = 7.7 Hz, 1H), 4.10 (s, 2H), 3.03 (t, J = 7.4 Hz, 1H), 2.57 (s, 3H), 2.47 (t, J = 6.7 Hz, 1H), 2.04 (q, J = 7.0 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 177.9, 156.2, 154.7, 147.4, 139.5, 139.4, 133.6, 133.3, 131.2, 131.1, 129.1, 126.6, 124.1, 123.7, 123.5, 122.8, 119.8, 117.0, 112.2, 106.9, 23.8, 22.7, 20.2, 17.0; HRMS $[M]^+$ Calculated for $C_{24}H_{19}BrN_2O_2$ 446.0630, found 446.0638.

4a-4e



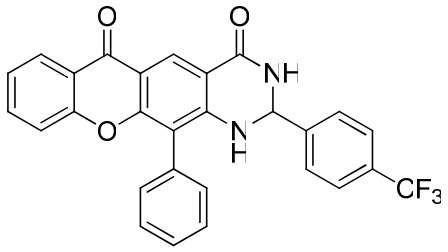
2, 12-diphenyl-2, 3-dihydro-1H-chromeno [3, 2-g] quinazoline-4, 6-dione (4a)

Following the general procedure, from 66 mg (0.2 mmol) of **3ae,** 71 mg (85%) of **4a** as a light-brown solid was obtained: m.p. 257-258 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.02 (s, 1H), 8.29 (d, *J* = 8.0 Hz, 1H), 7.3-7.7 (m, 12H), 7.15 (d, *J* = 8.3 Hz, 1H), 6.24 (s, 1H), 5.93 (s, 1H) 4.89 (s, 1H); ^{13}C NMR (100 MHz, *d6*-DMSO) δ 174.7, 161.7, 155.9, 155.3, 149.0, 142.7, 134.8, 131.1, 130.9, 130.2, 129.2, 128.5, 128.3, 128.1, 126.7, 125.8, 125.7, 124.3, 120.9, 117.7, 112.9, 112.6, 112.4, 65.2; HRMS $[M]^+$ Calculated for $C_{27}H_{18}N_2O_3$ 418.1317, found 418.1324.



2-(4-methoxyphenyl)-12-phenyl-2,3-dihydro-1H-chromeno[3,2-g]quinazoline-4,6-dione (4b)

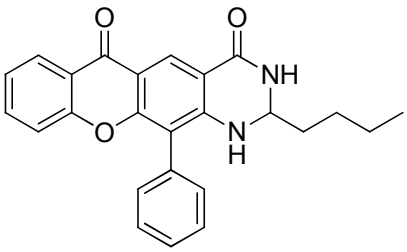
Following the general procedure, from 66 mg (0.2 mmol) of **3ae,** 71 mg (79%) of **4b** as a white solid was obtained: m.p. 278-279 ^{o}C; ^{1}H NMR (300 MHz, $CDCl_3$) δ 9.03 (s, 1H), 8.30 (d, *J* = 7.7 Hz, 1H), 7.28-7.63 (m, 9H), 7.15 (d, *J* = 8.5 Hz, 1H), 6.92 (d, *J* = 8.3 Hz, 2H), 6.06 (s, 1H), 5.88 (s, 1H), 4.83 (s, 1H), 3.81 (s, 3H); ^{13}C NMR (100 MHz, d_5-Pyridine) δ 175.8, 163.4, 160.5, 156.8, 150.6, 134.4, 134.1, 132.4, 131.5, 130.8, 129.5, 128.6, 128.5, 128.3, 126.5, 124.2, 122.1, 118.1, 114.4, 114.3, 114.2, 113.7, 67.7, 55.2; HRMS $[M]^+$ Calculated for $C_{28}H_{20}N_2O_4$ 448.1423, found 448.1408.



12-phenyl-2-(4-(trifluoromethyl)phenyl)-2,3-dihydro-1H-chromeno[3,2-g]quinazoline-4,6-dione (4c)

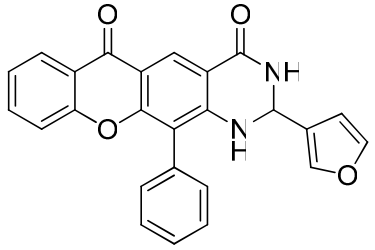
Following the general procedure, from 66 mg (0.2 mmol) of **3ae,** 69 mg (71%) of **4c** as a white solid was obtained: m.p. 263-264 ^{o}C; ^{1}H NMR (300 MHz, d_6-DMSO) δ 8.94 (d, *J* = 3.4 Hz, 1H), 8.55 (s, 1 H), 8.09 (dd, *J* =7.9 , 1.5 Hz, 1H), 7.73 (d, *J* = 8.5 Hz, 2H), 7.67 (td, *J* = 7.8 , 1.8 Hz, 1H), 7.37-7.63 (m, 8H), 7.17 (d, *J* = 3.4 Hz, 1H), 7.13 (d, *J* = 8.2 Hz, 1H), 5.82 (s, 1H); ^{13}C NMR (100 MHz, d_6-DMSO) δ: 174.7,

161.6, 155.3, 148.8, 147.1, 134.9, 131.1, 129.3, 128.4, 126.8, 126.7, 125.8, 125.6, 124.3, 120.8, 117.7, 112.9, 112.8, 112.6, 64.7; HRMS $[M]^+$ Calculated for $C_{28}H_{17}F_3N_2O_3$ 486.1191, found 486.1192.



2-butyl-12-phenyl-2,3-dihydro-1H-chromeno[3,2-g]quinazoline-4,6-dione (4d)

Following the general procedure, from 66 mg (0.2 mmol) of **3ae,** 60 mg (75%) of **4d** as a white solid was obtained: m.p. 212-213 ^oC; ^1H NMR (300 MHz, d_6-DMSO) δ 8.54 (s, 1H), 8.41 (d, J = 2.5 Hz, 1H), 8.11 (dd, J = 8.0 , 1.8 Hz, 1H), 7.69 (td, J = 8.5 , 1.8 Hz, 1H), 7.60 (t, J = 8.0 Hz, 2H), 7.47-7.55 (m, 2H), 7.36-7.46 (m, 2H), 7.15 (d, J = 8.5 Hz, 1H), 6.42 (s, 1H), 4.68 (m, 1H), 1.58-1.63 (m, 2H), 1.19-1.32 (m, 4H), 0.82 (t, J = 6.9 Hz, 3H); ^{13}C NMR (100 MHz, d_6-DMSO) δ: 174.7, 161.6, 155.8, 155.3, 149.5, 134.8, 131.3, 129.2, 128.4, 128.3, 128.2, 126.6, 125.8, 124.2, 120.9, 117.7, 112.7, 112.3, 112.0, 64.0, 36.8, 25.4, 21.8, 13.9; HRMS $[M]^+$ Calculated for $C_{25}H_{22}N_2O_3$ 398.1630, found 398.1623.

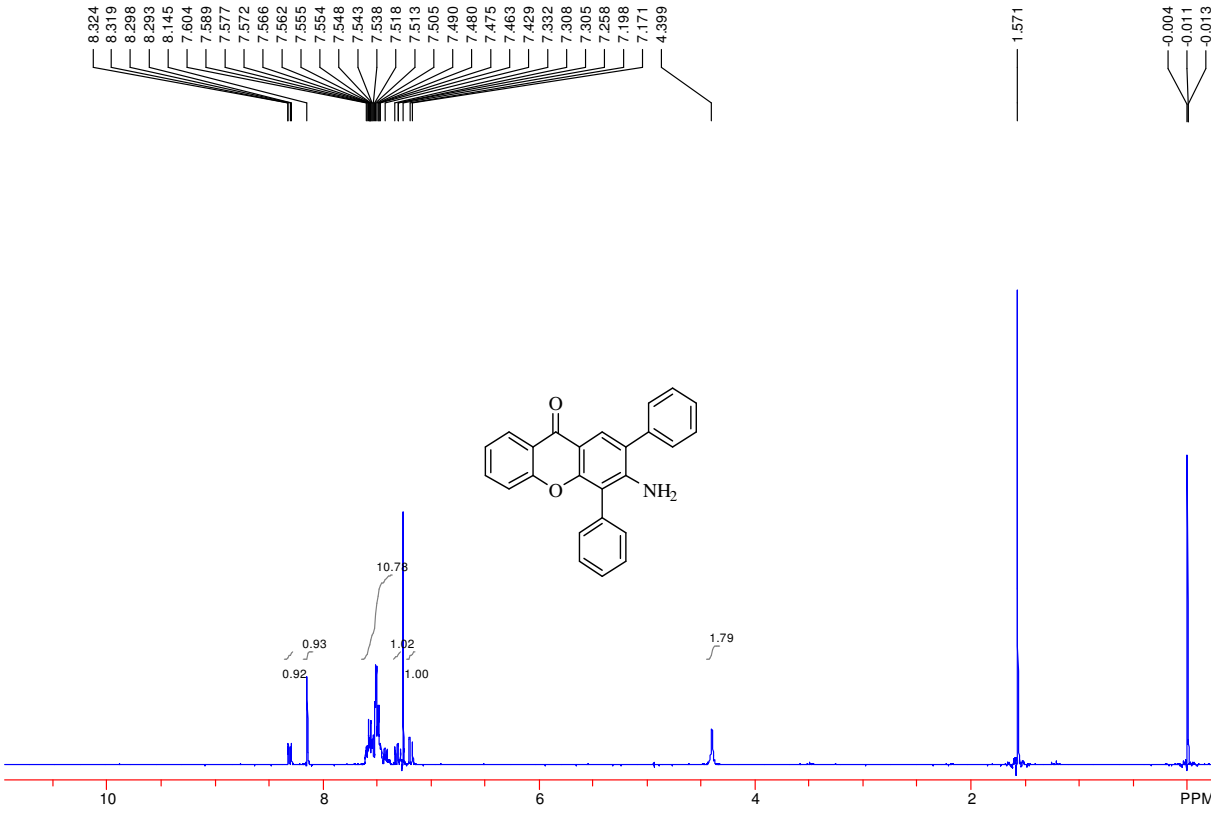


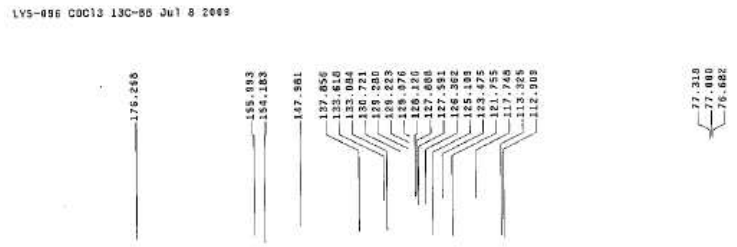
2-(furan-3-yl)-12-phenyl-2,3-dihydro-1H-chromeno[3,2-g]quinazoline-4,6-dione (4e)

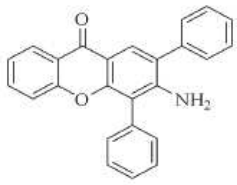
Following the general procedure, from 66 mg (0.2 mmol) of **3ae,** 68 mg (83%) of **4e** as a light-pink solid was obtained: m.p. 233-234 ^oC; ^1H NMR (300 MHz, d_6-DMSO) δ 8.74 (d, J = 3.8 Hz, 1H), 8.56 (s, 1H), 8.09 (d, J = 7.9 Hz, 1H), 7.67 (t, J = 7.9 Hz, 1H), 7.31-7.62 (m, 8 H), 7.13 (d, J = 8.5 Hz, 1H), 6.86 (d, J = 2.6 Hz, 1H), 6.41 (s, 1H), 5.66 (s, 1H); ^{13}C NMR (100 MHz, d_6-DMSO) δ: 174.8, 162.0, 155.9, 155.3, 149.0, 144.0, 139.8, 134.9, 131.2, 130.8, 130.3, 129.3, 128.3, 126.7, 125.8, 124.3, 120.9, 117.7, 113.2, 113.1, 112.5, 108.9, 59.2; HRMS $[M]^+$ Calculated for $C_{25}H_{16}N_2O_4$ 408.1110, found 408.11120.

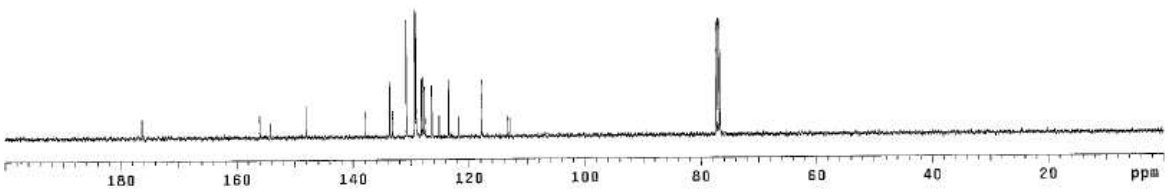
3. ^{1}H NMR and ^{13}C NMR spectra

3aa









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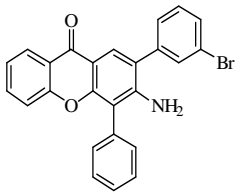
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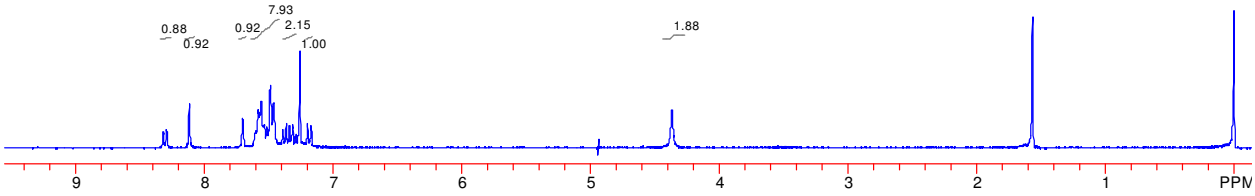
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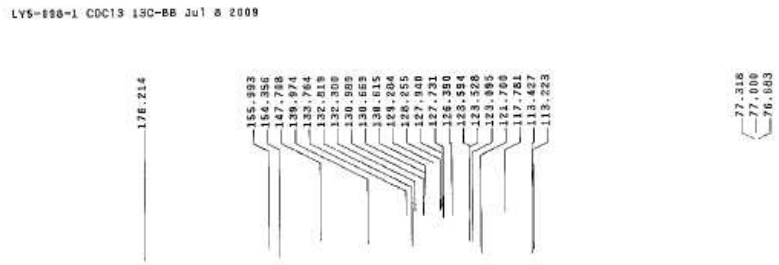
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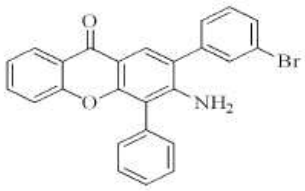
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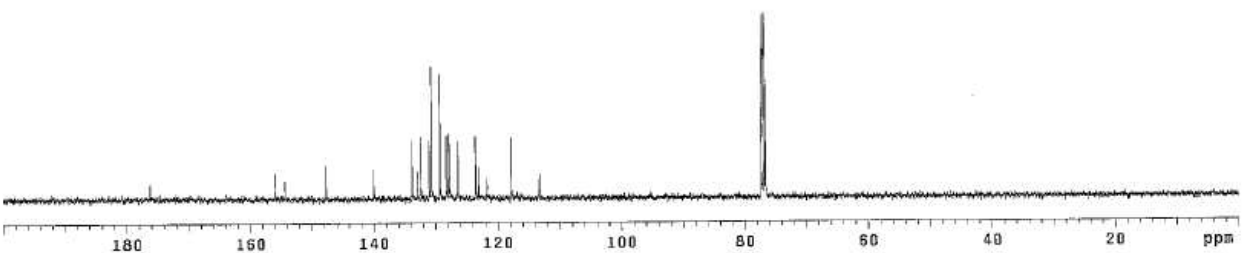
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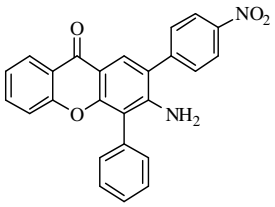
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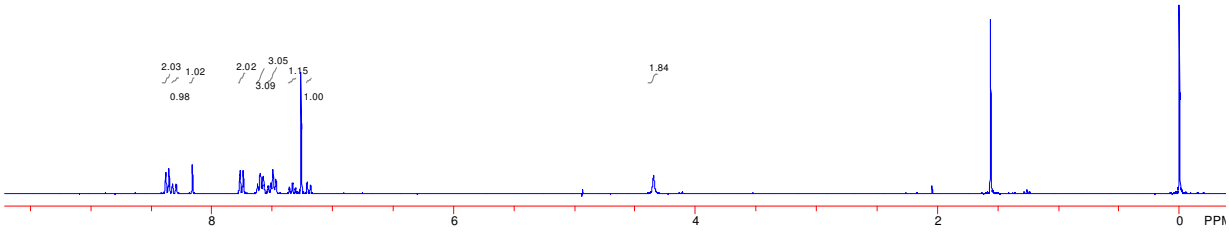
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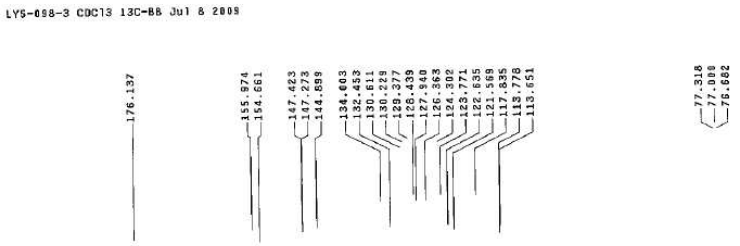
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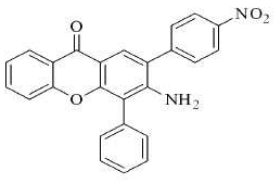
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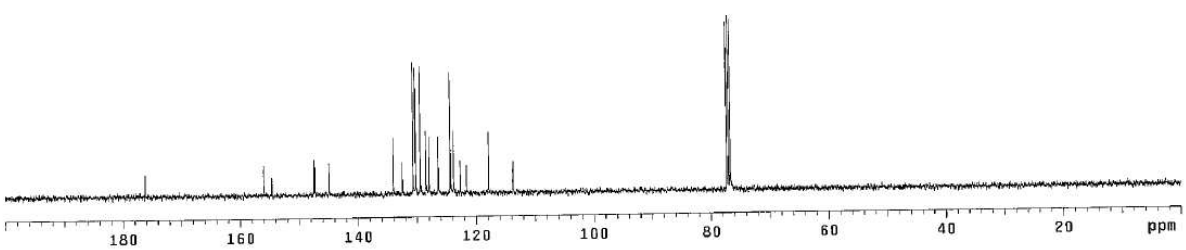
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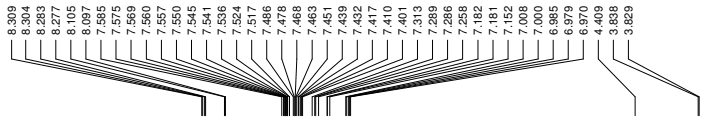
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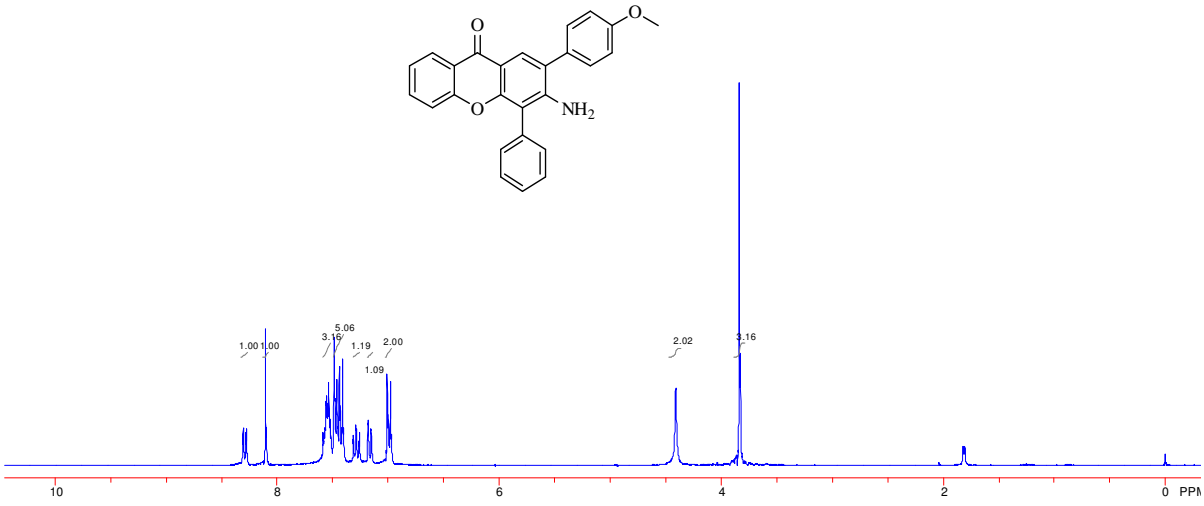
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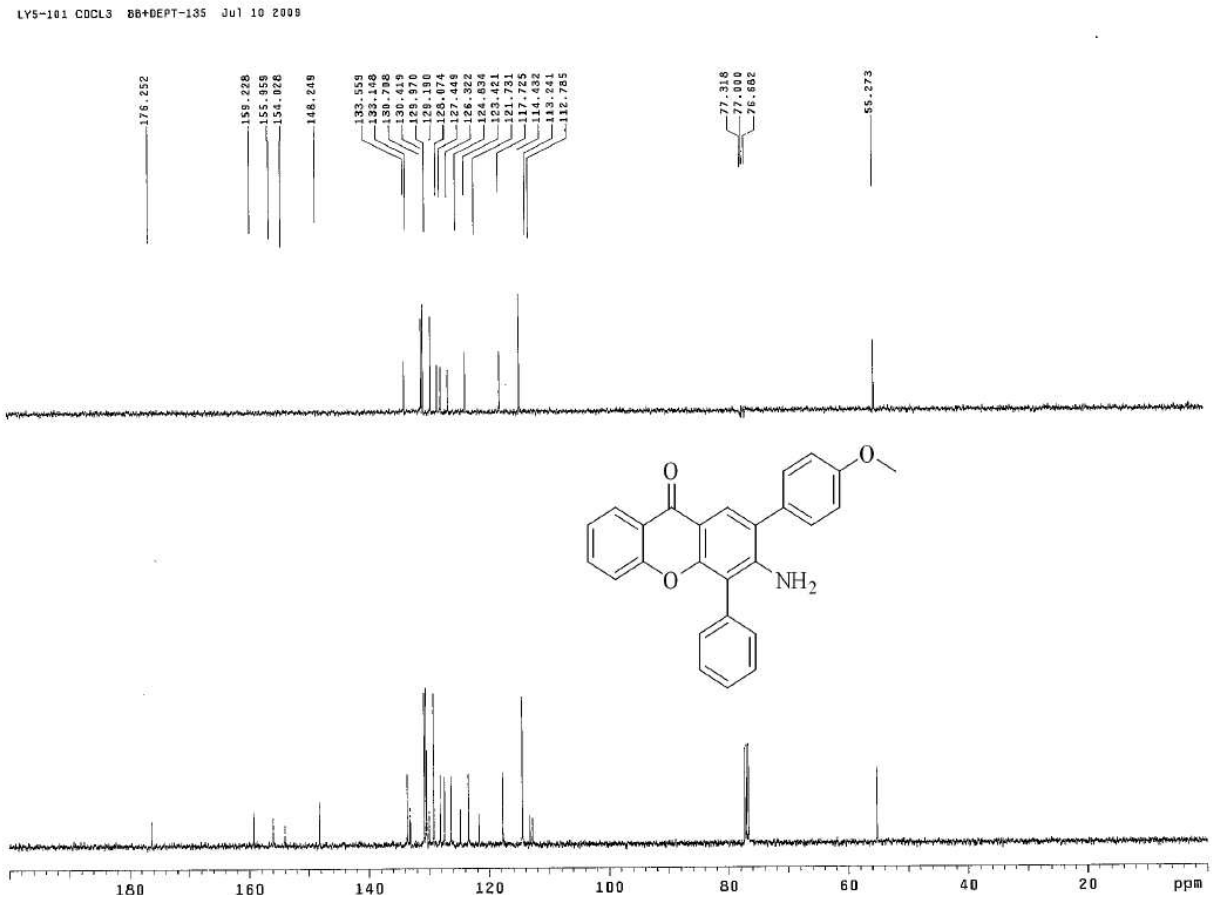
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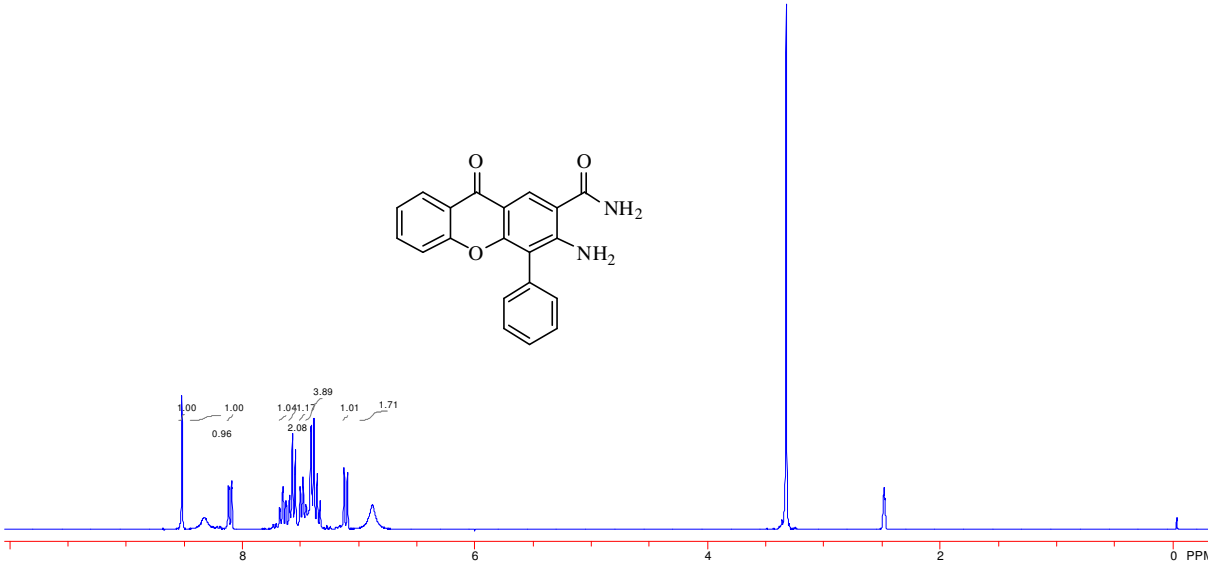
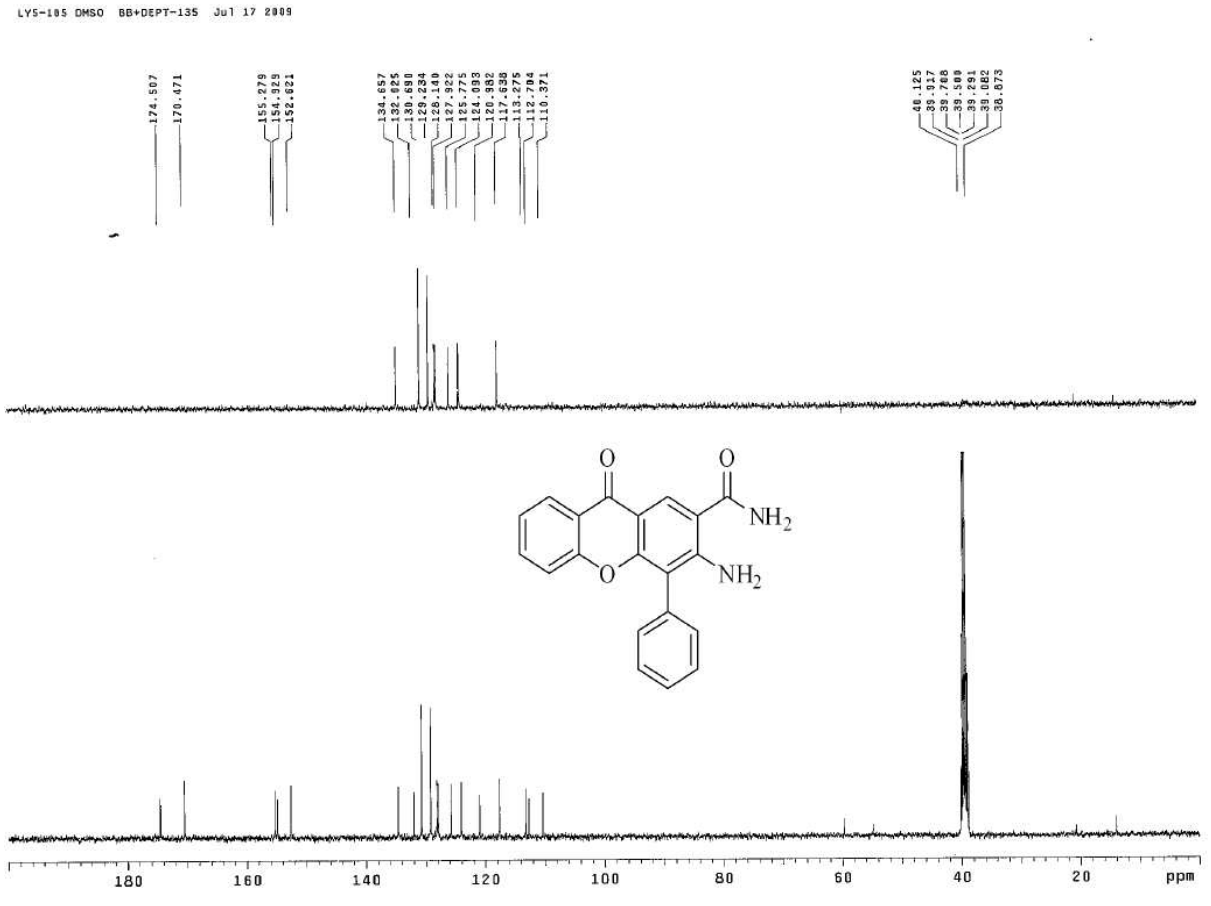
140
120
100
80
60
40
20
ppm

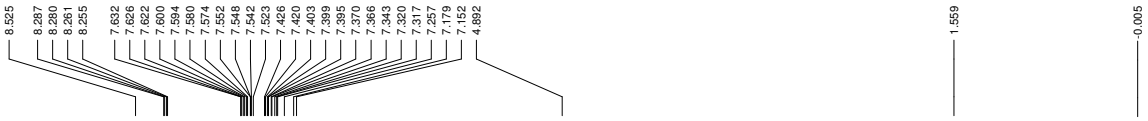
3ae

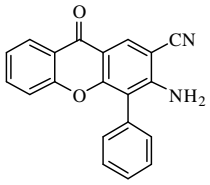

8.517
8.331
8.328
8.326
8.321
8.118
8.113
8.092
8.088
7.677
7.673
7.649
7.626
7.621
7.593
7.570
7.544
7.499
7.476
7.467
7.451
7.440
7.412
7.408
7.384
7.356
7.332
7.125
7.098
6.886
6.882
6.880
5.724
3.323
2.486
2.481
2.475
-0.036

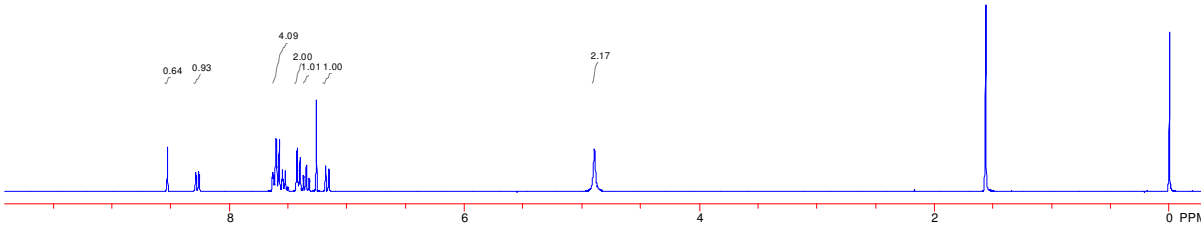

O
O
NH2
O
NH2
1.00
1.00
0.96
1.04
1.17
3.89
2.08
1.01
1.71
8
6
4
2
0 PPM

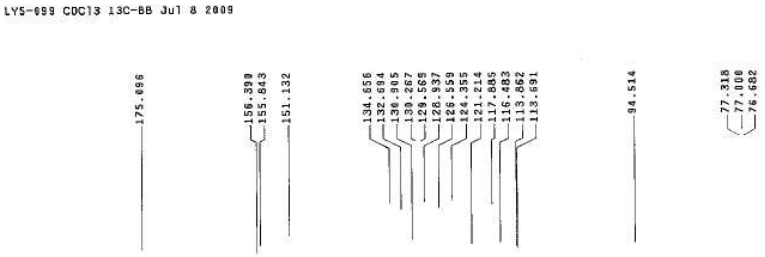

LYS-185 DMSO BB+DEPT-135 Jul 17 2009
174.507
170.471
155.279
154.929
152.621
134.657
132.685
129.634
128.140
127.922
125.775
124.093
120.982
117.638
113.275
112.704
110.371
40.125
39.917
39.708
39.500
39.291
39.082
38.873
O
O
NH2
O
NH2
180
160
140
120
100
80
60
40
20
ppm

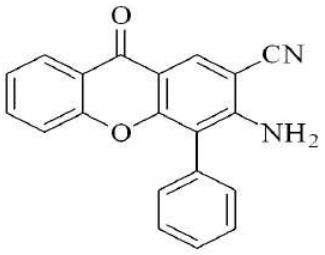
3af

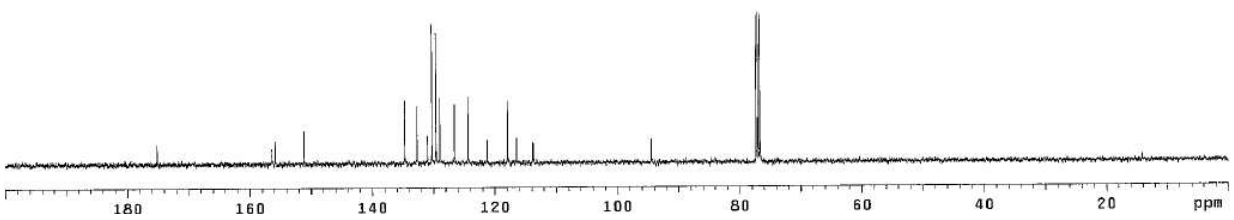

8.525
8.287
8.280
8.261
8.255
7.632
7.626
7.622
7.600
7.594
7.580
7.574
7.552
7.548
7.542
7.523
7.426
7.420
7.403
7.399
7.395
7.370
7.366
7.343
7.320
7.317
7.257
7.179
7.152
4.892
1.559
0.005


O
CN
O
NH2


4.09
2.00
1.01
1.00
0.64
0.93
2.17
8
6
4
2
0 PPM

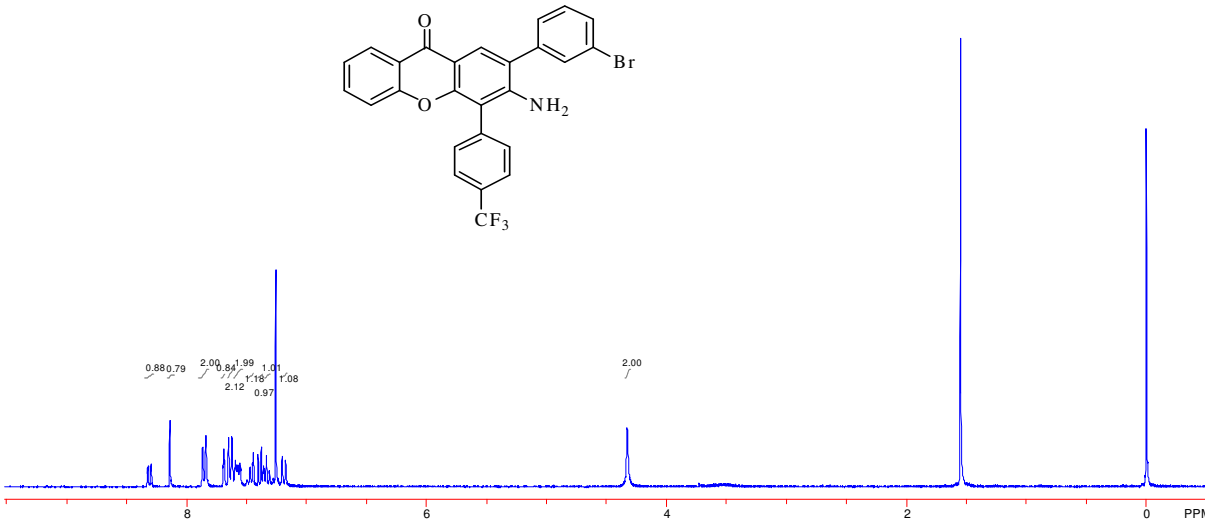

LYS-099 CDCl3 13C-BB Jul 8 2009
175.096
156.399
155.843
151.132
134.656
132.694
130.905
130.267
129.565
128.937
126.559
124.355
121.214
117.885
116.483
113.862
113.691
94.514
77.318
77.000
76.682

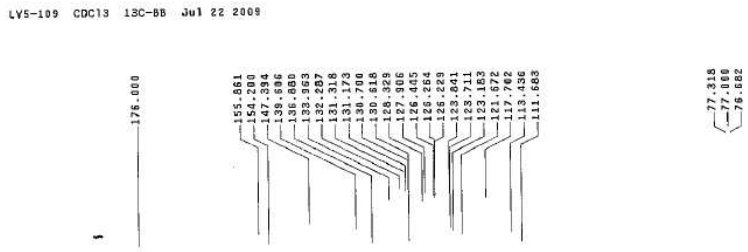

O
CN
O
NH2

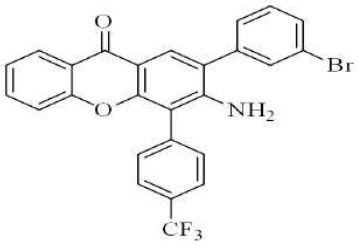

180
160
140
120
100
80
60
40
20
ppm

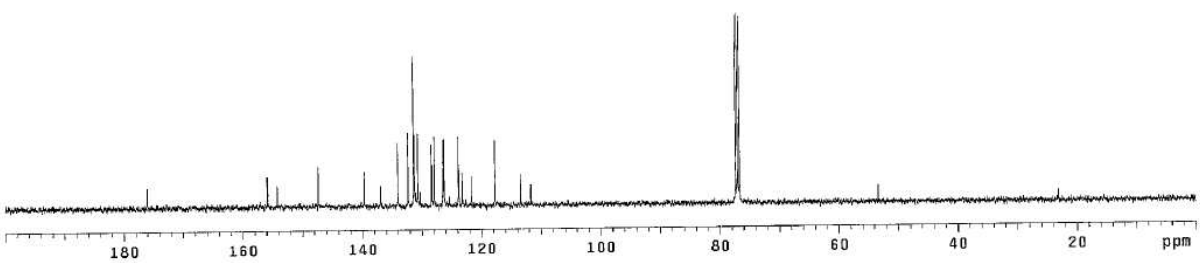
3bb


8.322
8.299
8.295
8.140
7.865
7.839
7.696
7.690
7.683
7.650
7.622
7.593
7.587
7.579
7.570
7.564
7.553
7.471
7.450
7.446
7.402
7.375
7.357
7.334
7.258
7.203
7.175
4.327
1.548
-0.002


O
Br
O
NH2
CF3
0.88
0.79
2.00
0.84
1.99
2.12
1.18
1.01
0.97
1.08
2.00
8
6
4
2
0
PPM

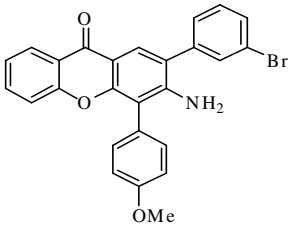

LY5-109 CDCl3 13C-BB Jul 22 2009
176.000
155.861
154.200
147.394
136.686
136.880
133.363
132.257
131.318
131.173
130.700
130.618
128.329
127.906
126.445
126.264
126.229
123.841
123.711
123.183
121.672
117.762
113.436
111.683
77.318
77.000
76.682

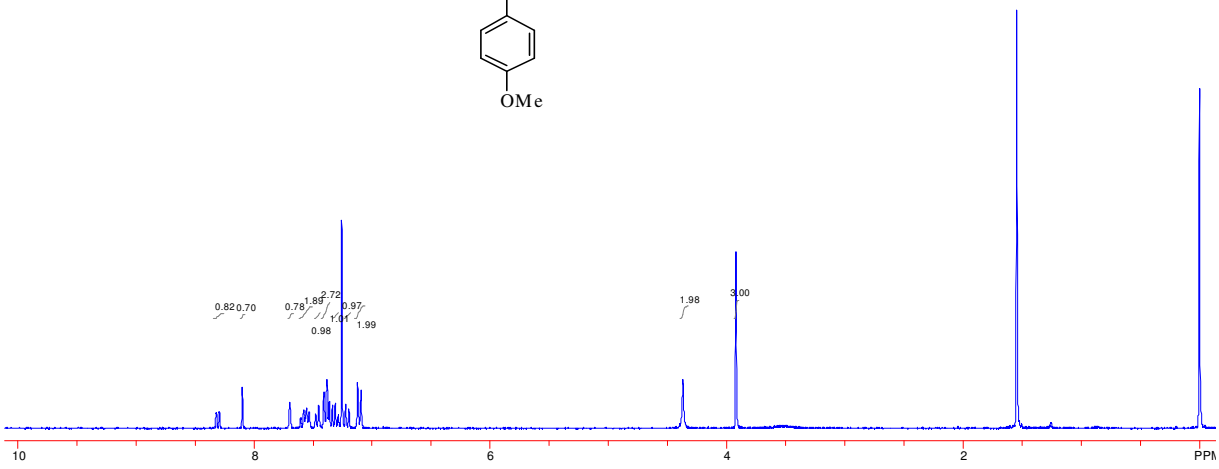

O
Br
O
NH2
CF3


180
160
140
120
100
80
60
40
20
ppm

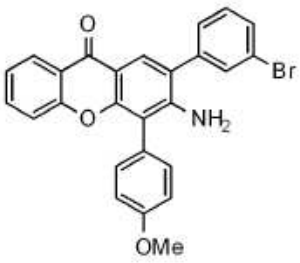
3bc

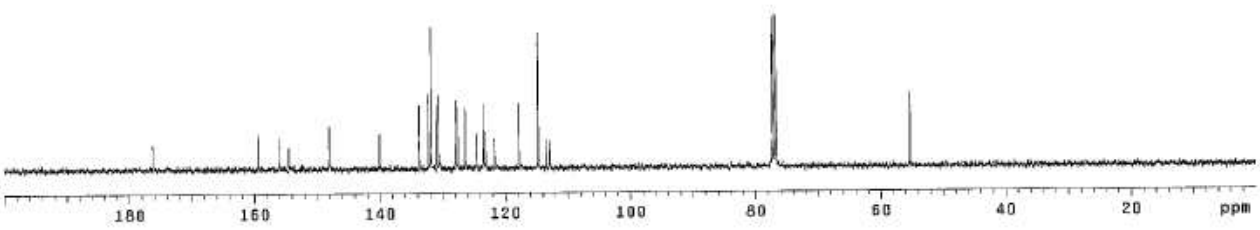

8.320
8.292
8.100
7.698
7.602
7.576
7.554
7.531
7.477
7.452
7.408
7.381
7.371
7.362
7.337
7.313
7.287
7.259
7.222
7.196
7.122
7.093
4.371
3.920
1.546
0.003


O
Br
O
NH2
OMe


0.82
0.70
0.78
1.89
2.72
0.97
1.01
0.98
1.99
1.98
3.00
10
8
6
4
2
PPM

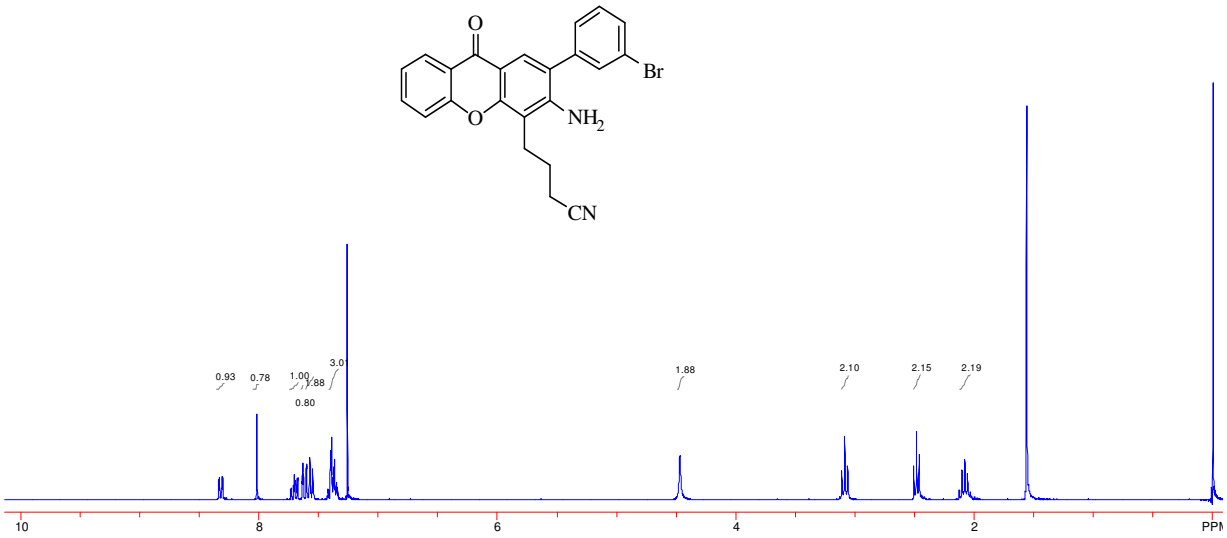

176.252
159.407
156.007
154.542
148.927
149.054
138.734
132.276
131.888
130.930
130.584
127.971
127.500
126.367
124.824
123.541
123.447
123.082
121.655
117.766
114.764
113.461
112.967
77.319
77.000
76.683
55.339

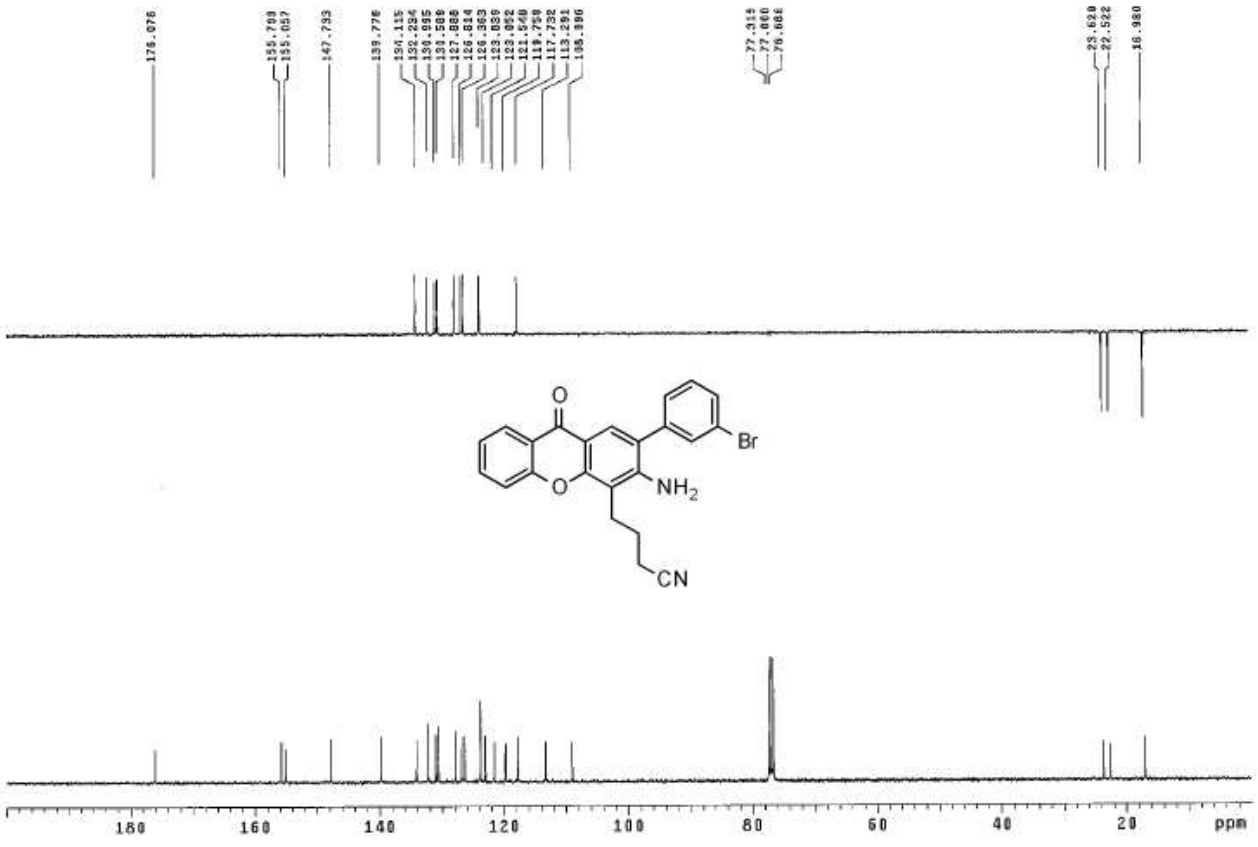

O
Br
O
NH2
OMe


180
160
140
120
100
80
60
40
20
ppm

3bd

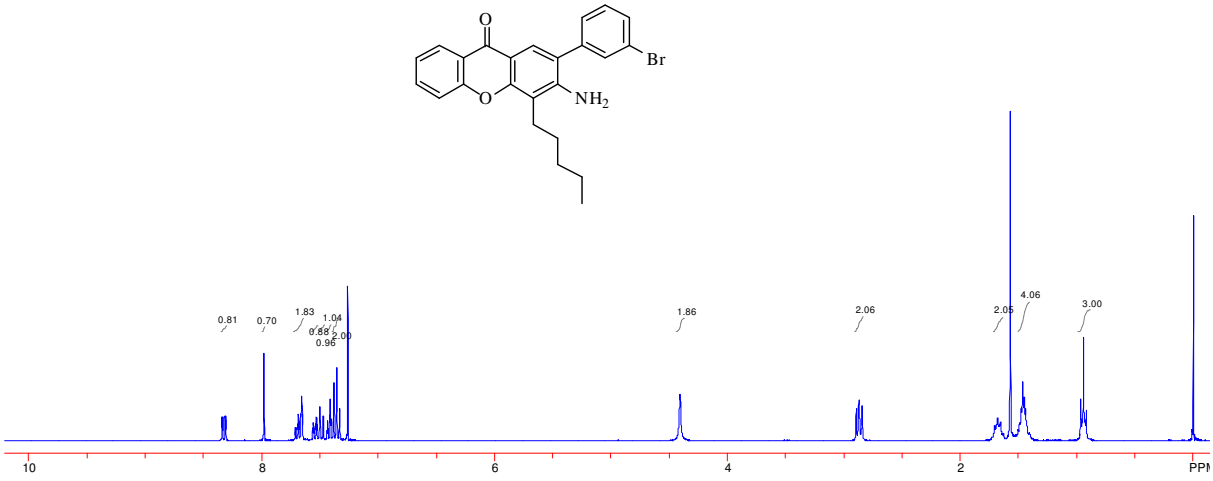

8.335
8.330
8.309
8.304
8.017
7.709
7.703
7.698
7.680
7.675
7.638
7.633
7.627
7.602
7.600
7.571
7.565
7.553
7.547
7.541
7.400
7.394
7.388
7.378
7.374
7.371
7.364
7.351
7.347
7.258
4.469
3.110
3.086
3.062
2.506
2.485
2.461
2.102
2.078
2.056
1.560
0.008
-0.003

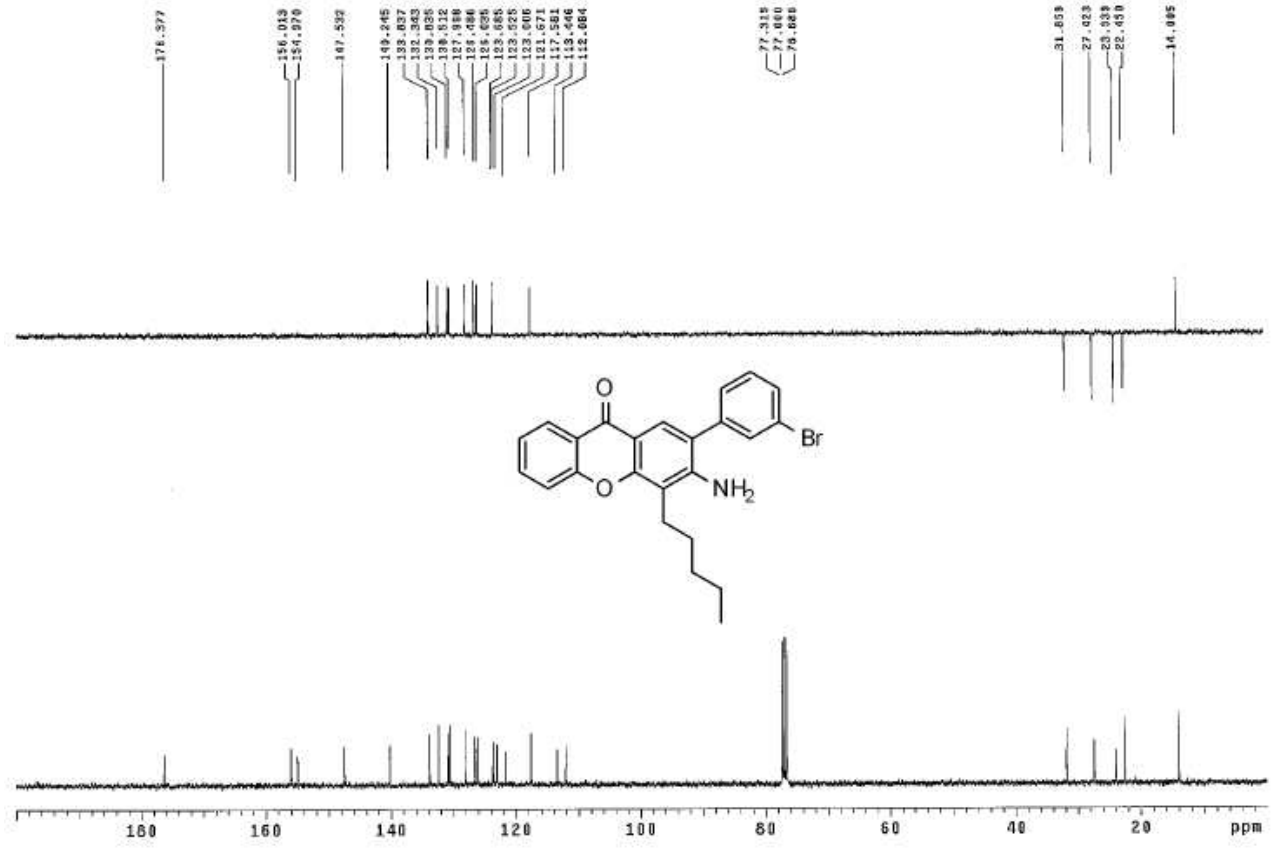

O
Br
O
NH2
CN
0.93
0.78
1.00
0.88
0.80
3.0
1.88
2.10
2.15
2.19
10
8
6
4
2
PPM


176.978
155.799
155.057
147.733
139.778
134.115
132.234
130.995
130.588
127.088
126.814
126.363
123.039
123.052
121.540
119.759
117.732
113.291
105.886
77.316
77.000
76.684
23.620
22.522
16.380
O
Br
O
NH2
CN
180
160
140
120
100
80
60
40
20
ppm

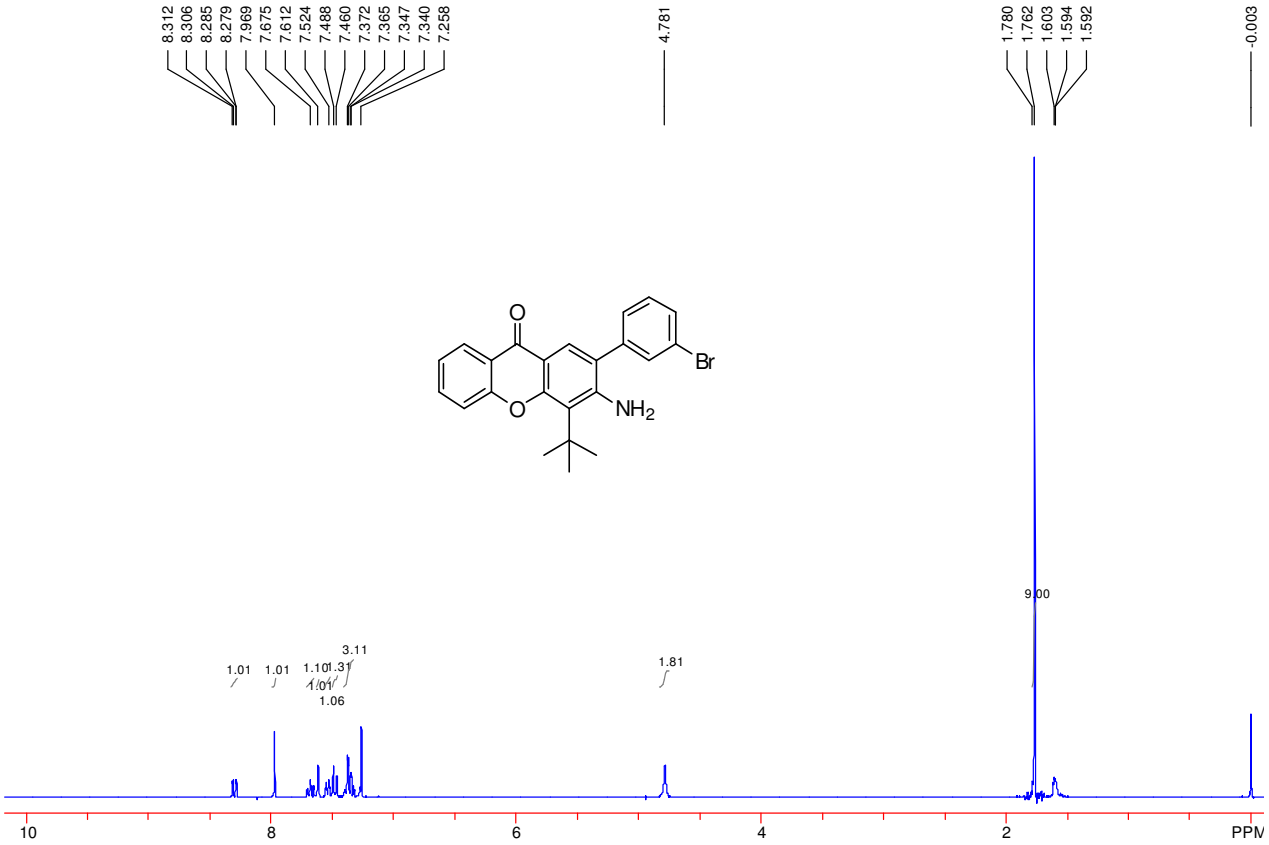
3be

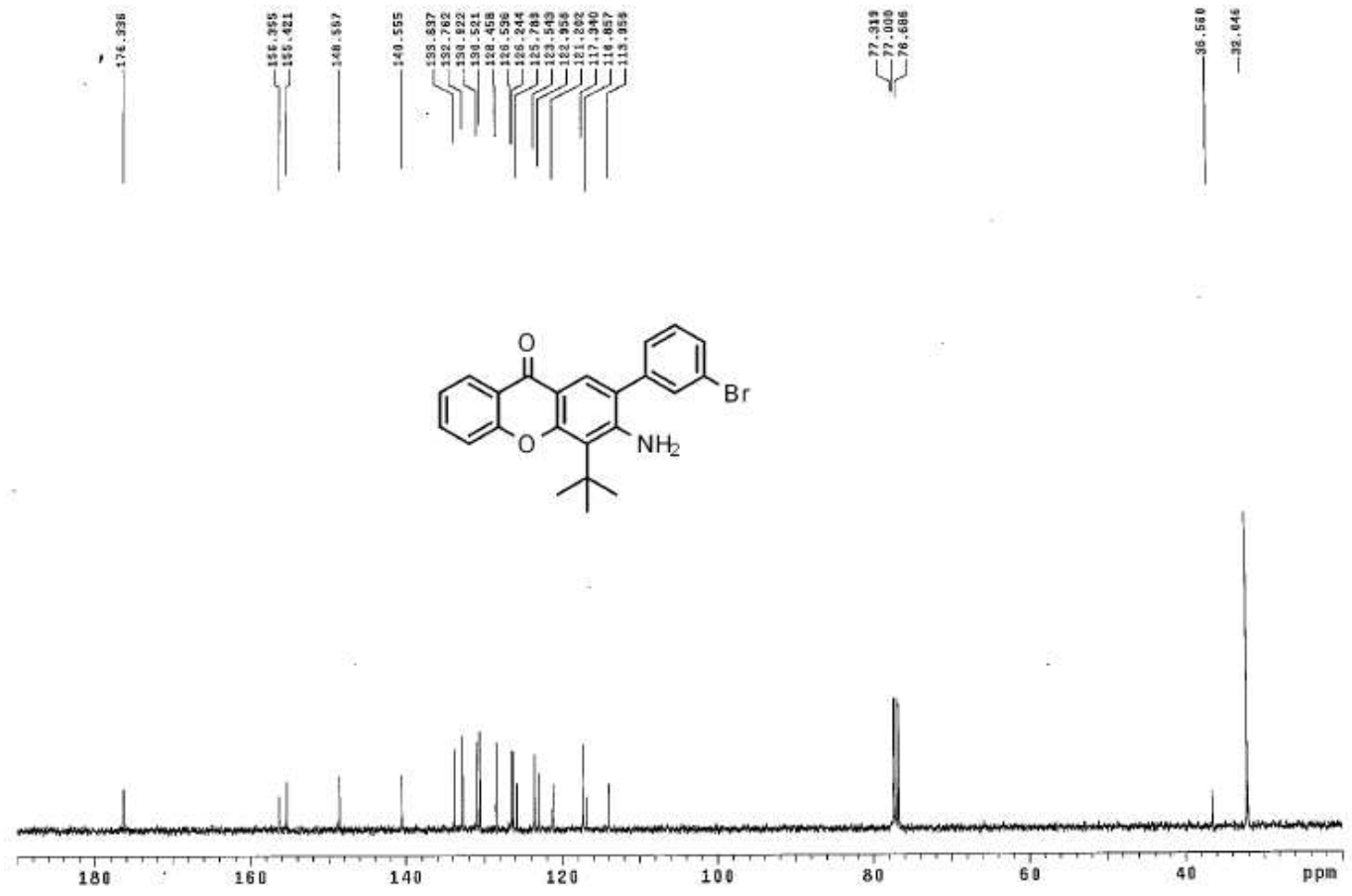

8.338
8.332
8.311
8.306
7.979
7.712
7.705
7.688
7.682
7.679
7.660
7.654
7.651
7.645
7.559
7.553
7.532
7.528
7.521
7.497
7.472
7.433
7.411
7.407
7.403
7.376
7.352
7.326
7.259
4.406
2.893
2.866
2.841
1.702
1.679
1.652
1.568
1.489
1.474
1.462
1.449
1.438
0.965
0.942
0.917
-0.004


O
Br
O
NH2
0.81
0.70
1.83
1.04
0.88
0.96
2.00
1.86
2.06
2.05
4.06
3.00
10
8
6
4
2
PPM


176.577
156.013
154.070
147.532
149.245
133.837
132.343
129.512
127.988
124.486
123.685
123.525
123.606
121.671
117.581
113.446
112.084
77.315
77.000
76.688
31.659
27.423
23.333
22.450
14.095
O
Br
O
NH2
180
160
140
120
100
80
60
40
20
ppm

3bf


8.312
8.306
8.285
8.279
7.969
7.675
7.612
7.524
7.488
7.460
7.372
7.365
7.347
7.340
7.258
4.781
1.780
1.762
1.603
1.594
1.592
-0.003
O
Br
O
NH2
9.00
1.01
1.01
1.10
1.31
3.11
1.04
1.06
1.81
10
8
6
4
2
PPM


O
Br
O
NH2
ppm

3bg


8.114
8.089
7.576
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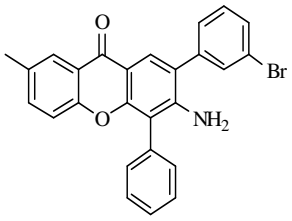
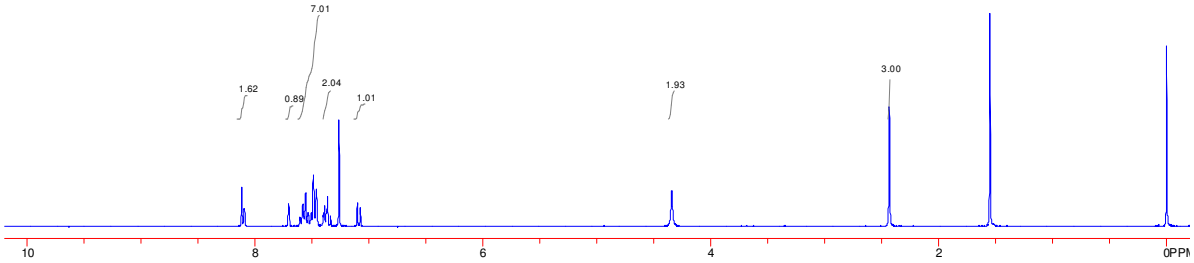
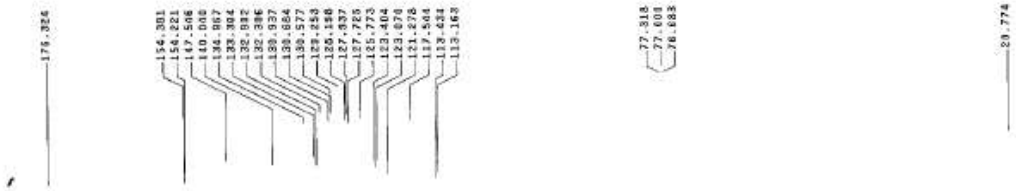
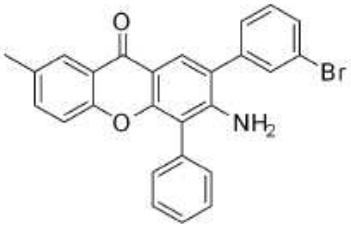
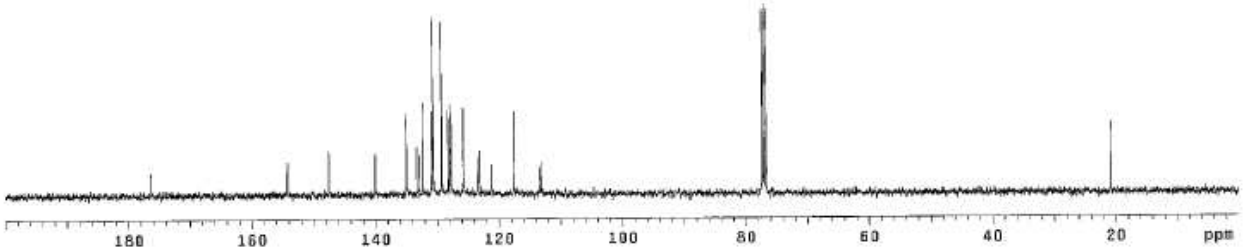
7.541
7.530
7.526
7.503
7.486
7.458
7.398
7.386
7.371
7.360
7.258
7.101
7.072
4.341
2.433
1.549
0.001


O
Br
O
NH2

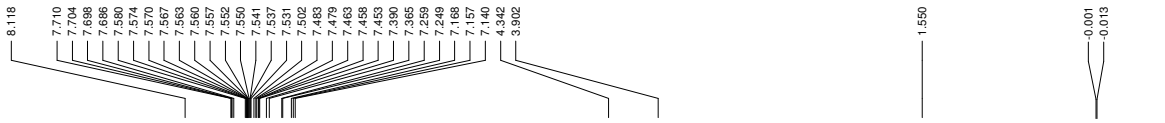

7.01
1.62
0.89
2.04
1.01
1.93
3.00
10
8
6
4
2
0PPM

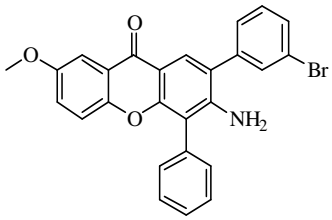

176.324
154.301
154.221
147.566
140.048
134.967
133.304
132.942
132.386
130.937
130.854
130.577
129.253
126.156
127.937
127.725
125.773
123.404
123.078
121.278
117.564
113.434
113.163
77.318
77.001
76.683
29.774

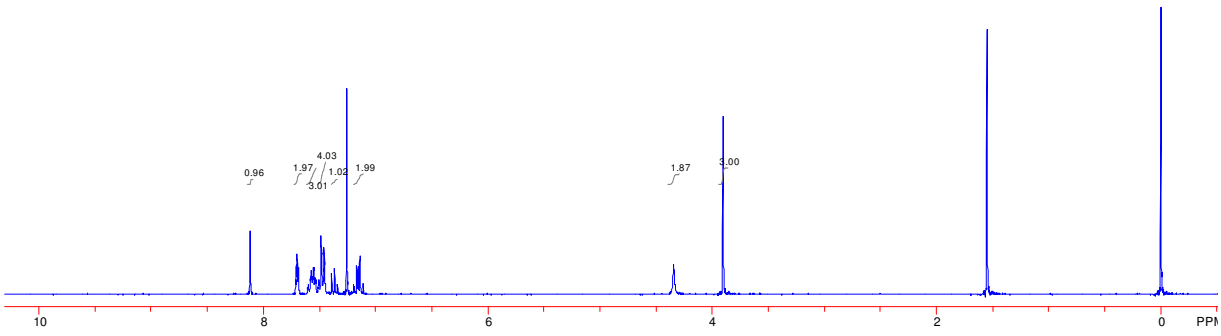

O
Br
O
NH2

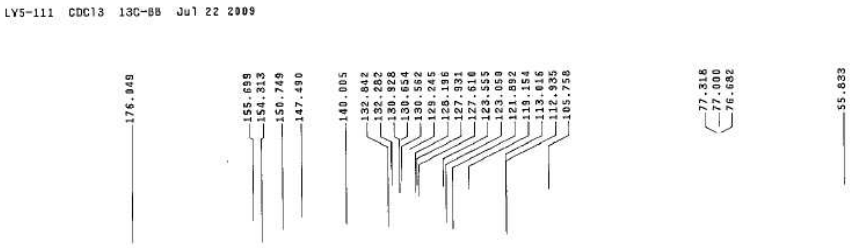

180
160
140
120
100
80
60
40
20
ppm

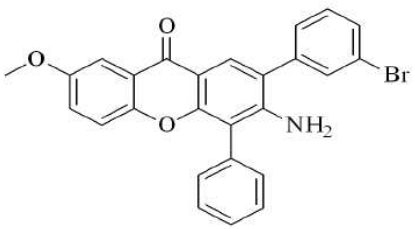
3bh

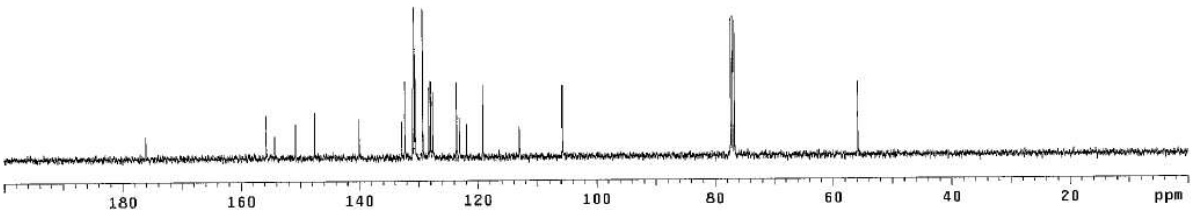

8.118
7.710
7.704
7.698
7.686
7.580
7.574
7.570
7.567
7.563
7.560
7.557
7.552
7.550
7.541
7.537
7.531
7.502
7.483
7.479
7.463
7.458
7.453
7.390
7.365
7.259
7.249
7.168
7.157
7.140
4.342
3.902
1.550
0.001
-0.013


O
O
Br
O
NH2


0.96
1.97
4.03
3.01
1.02
1.99
1.87
3.00
10
8
6
4
2
0
PPM

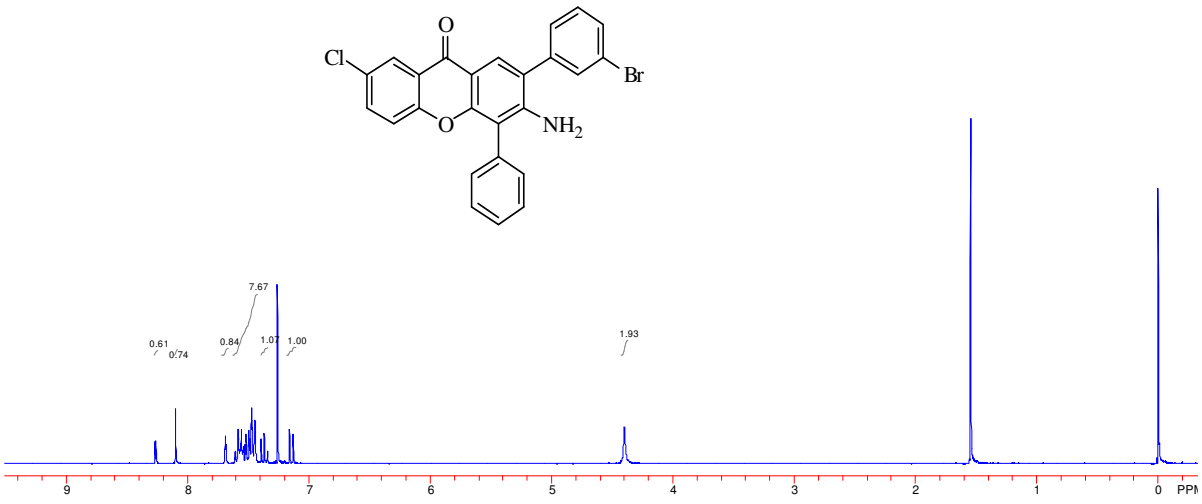

LY5-111 CDCl3 13C-BB Jul 22 2009
176.849
155.699
154.313
150.749
147.490
140.005
132.842
132.282
130.654
130.562
129.245
128.196
127.331
127.610
123.555
123.050
121.892
119.154
113.616
112.935
105.758
77.318
77.000
76.682
55.883


O
O
Br
O
NH2


180
160
140
120
100
80
60
40
20
ppm

3bi


8.268
8.259
8.098
7.690
7.683
7.582
7.578
7.562
7.559
7.543
7.523
7.516
7.494
7.485
7.475
7.469
7.444
7.393
7.366
7.259
7.158
7.128
4.400
1.546
0.003
-0.011


O
Cl
Br
O
NH2
7.67
0.61
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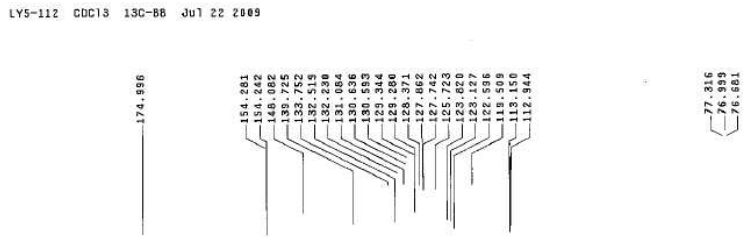
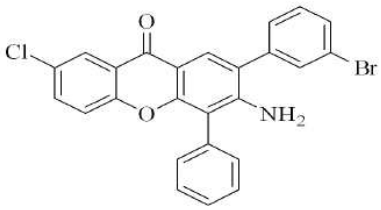
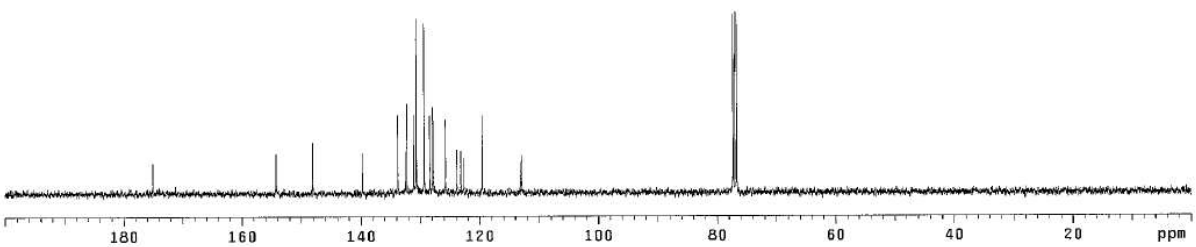
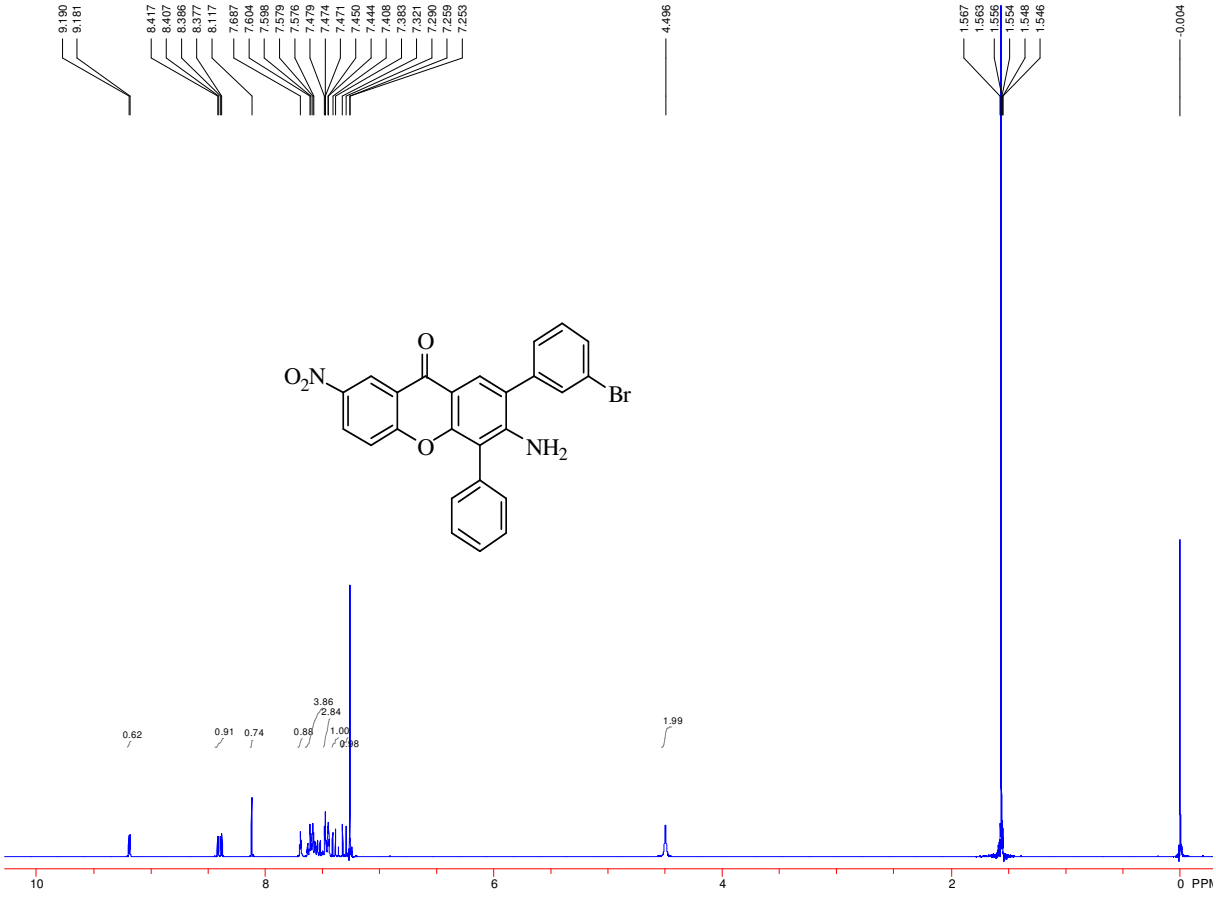
0.84
1.07
1.00
1.93
9
8
7
6
5
4
3
2
1
0
PPM


LY5-112 CDCl3 13C-BB Jul 22 2009
174.956
154.281
154.242
146.082
139.725
133.752
132.515
132.288
131.084
130.593
129.344
129.280
128.371
127.862
127.742
125.723
123.820
123.127
122.596
119.509
113.150
112.944
77.316
76.999
76.681


O
Cl
Br
O
NH2


180
160
140
120
100
80
60
40
20
ppm

3bj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9.181
8.417
8.407
8.386
8.377
8.117
7.687
7.604
7.598
7.579
7.576
7.479
7.474
7.471
7.450
7.444
7.408
7.383
7.321
7.290
7.259
7.253
4.496
1.567
1.563
1.556
1.554
1.548
1.546
0.004
O
O2N
Br
O
NH2
0.62
0.91
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3.86
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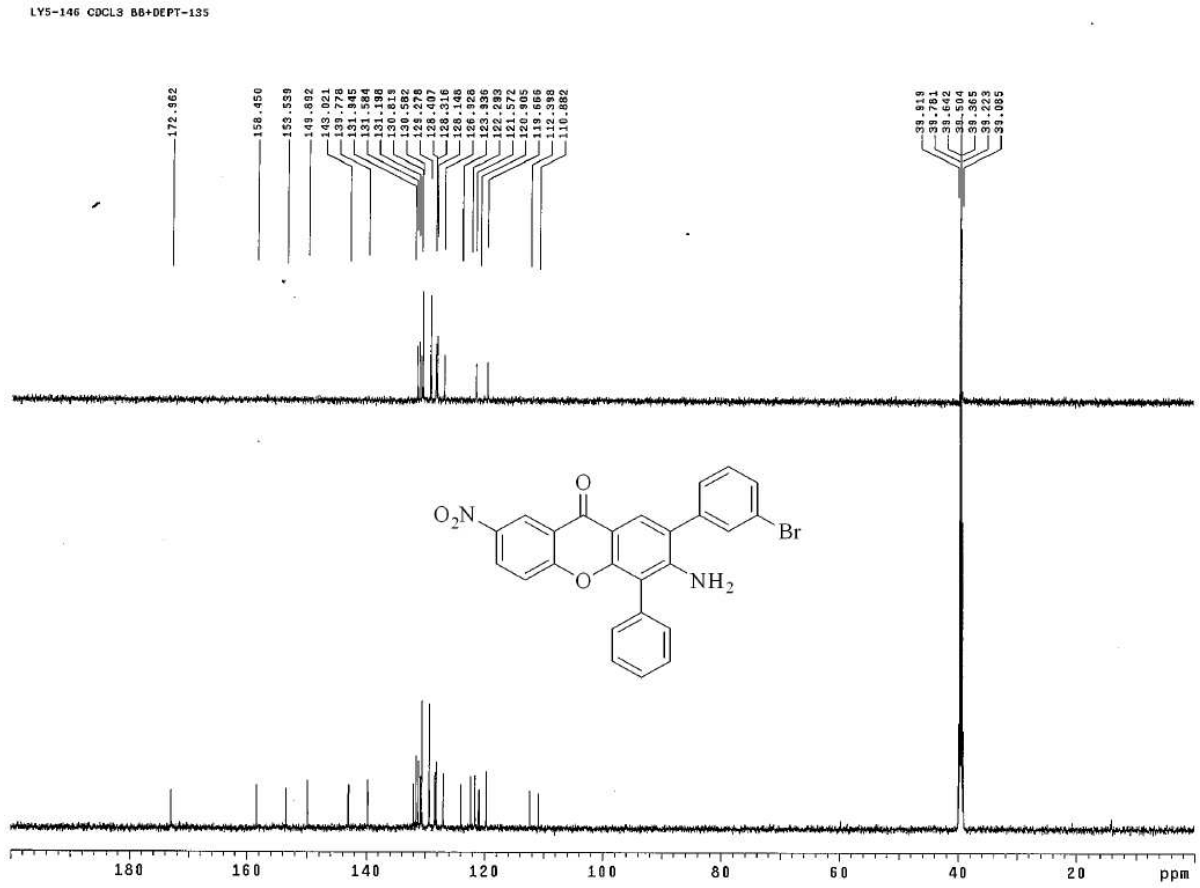
1.00
0.98
1.99
10
8
6
4
2
0 PPM


LY5-146 CDCL3 BB+DEPT-135
172.962
158.450
153.539
149.892
148.021
133.778
131.945
131.584
131.198
130.819
130.582
129.276
128.407
128.316
128.148
126.920
123.936
122.283
121.572
120.905
119.666
112.398
110.882
39.919
39.761
39.642
39.504
39.365
39.223
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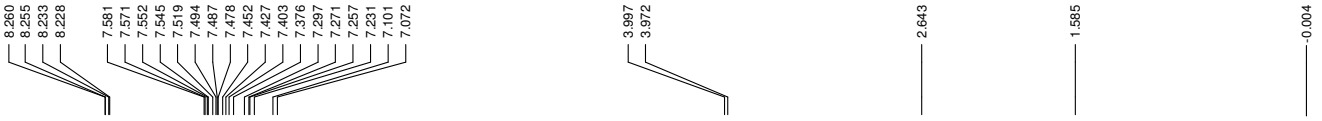
O
O2N
Br
O
NH2
180
160
140
120
100
80
60
40
20
ppm

3bk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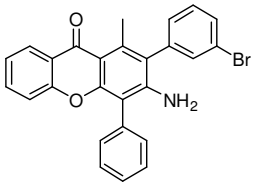
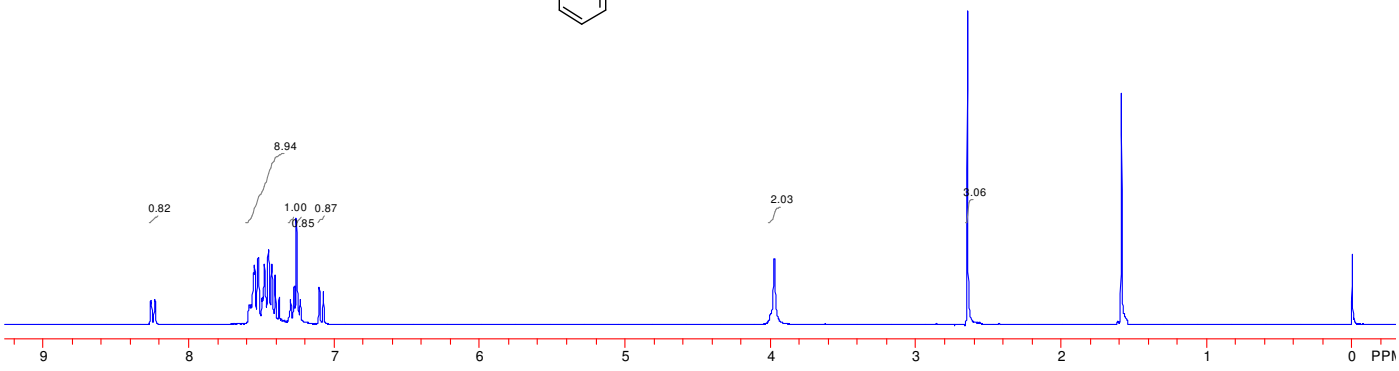
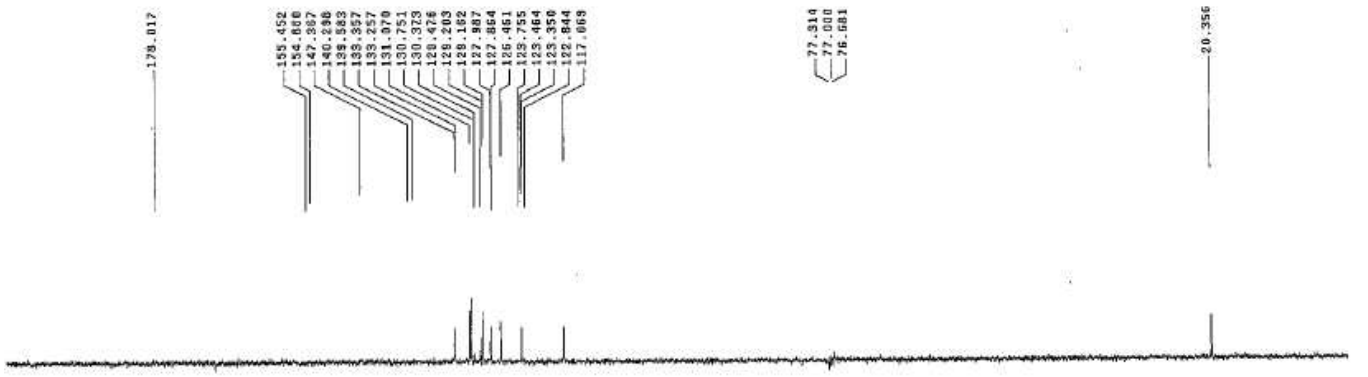
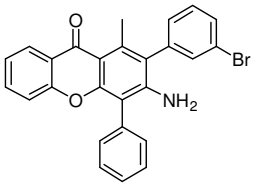
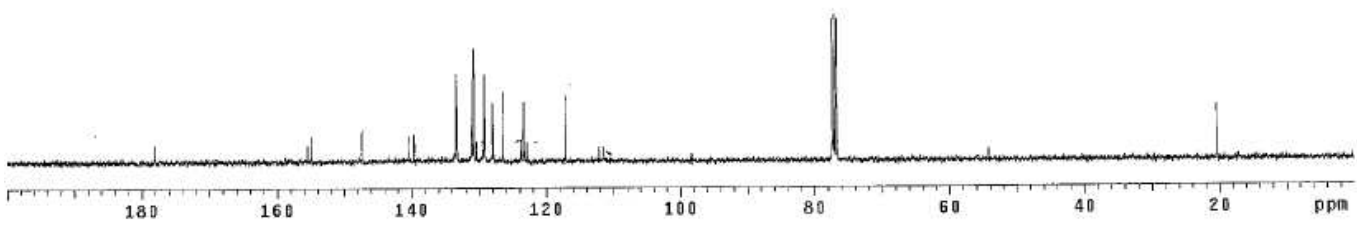
8.255
8.233
8.228
7.581
7.571
7.552
7.545
7.519
7.494
7.487
7.478
7.452
7.427
7.403
7.376
7.297
7.271
7.257
7.231
7.101
7.072
3.997
3.972
2.643
1.585
-0.004


O
Br
O
NH2

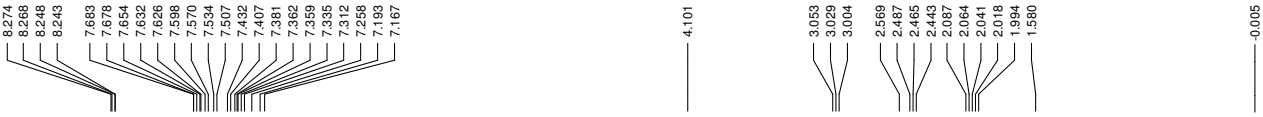

8.94
0.82
1.00
0.87
0.85
2.03
3.06
9
8
7
6
5
4
3
2
1
0
PPM

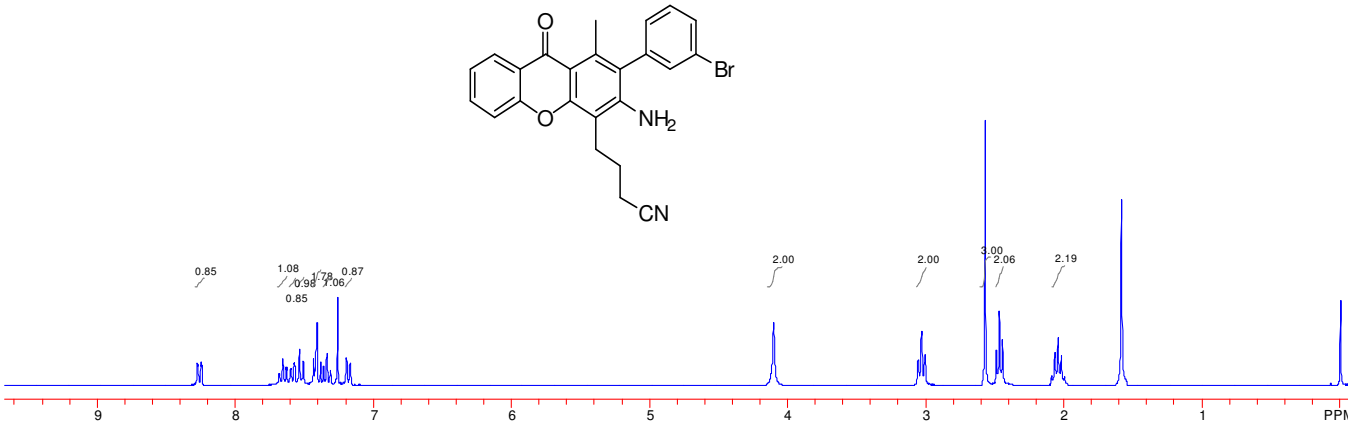

179.017
155.452
154.866
147.387
140.296
139.583
139.357
133.257
131.070
130.751
130.323
129.476
129.203
129.182
127.987
127.864
126.461
125.755
123.464
123.356
122.844
117.068
77.314
77.000
76.681
20.356

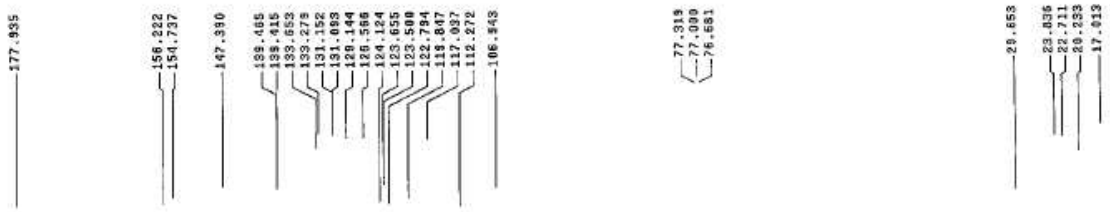

O
Br
O
NH2


180
160
140
120
100
80
60
40
20
ppm

3bl


8.274
8.268
8.248
8.243
7.683
7.678
7.654
7.632
7.626
7.598
7.570
7.534
7.507
7.432
7.407
7.381
7.362
7.339
7.335
7.312
7.258
7.193
7.167
4.101
3.053
3.029
3.004
2.569
2.487
2.465
2.443
2.087
2.064
2.041
2.018
1.994
1.580
-0.005


O
Br
O
NH2
CN
0.85
1.08
0.98
1.78
7.06
0.87
0.85
2.00
2.00
3.00
2.06
2.19
9
8
7
6
5
4
3
2
1
PPM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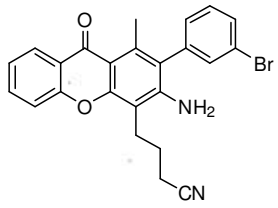
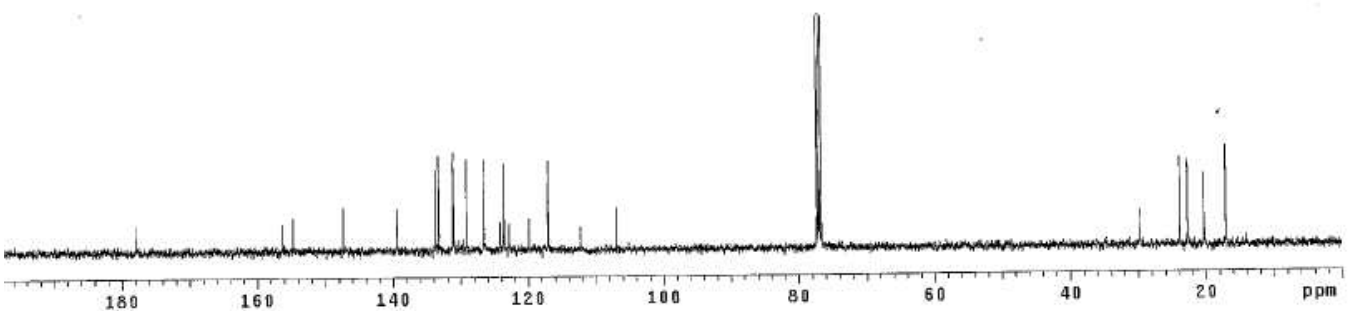
154.737
147.390
139.405
138.415
133.653
133.275
131.152
131.093
128.144
126.566
124.124
123.655
123.500
122.794
119.847
117.037
112.272
106.843
77.319
77.000
76.681
29.653
23.836
22.711
20.233
17.013


O
Br
O
NH2
CN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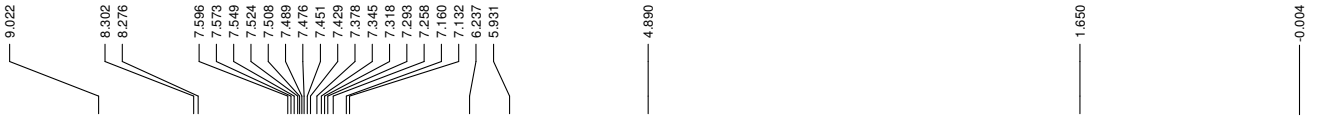
160
140
120
100
80
60
40
20
ppm

4a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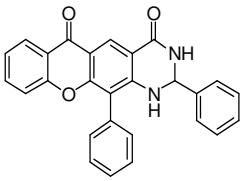
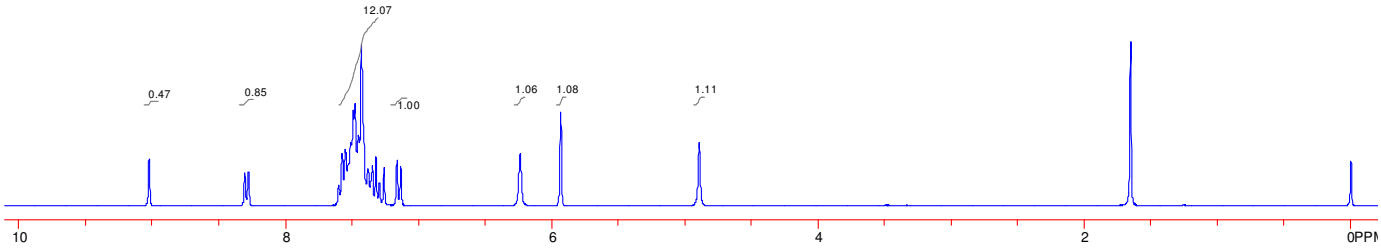
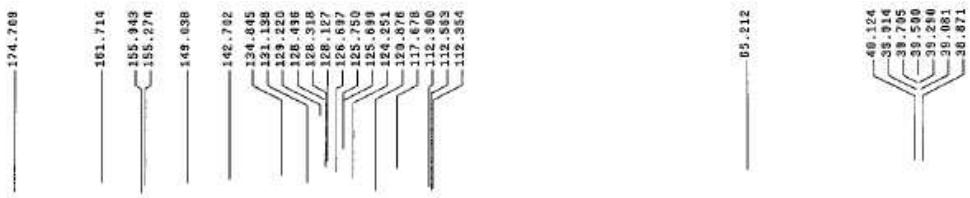
8.276
7.596
7.573
7.549
7.524
7.508
7.489
7.476
7.451
7.429
7.378
7.345
7.318
7.293
7.258
7.160
7.132
6.237
5.931
4.890
1.650
-0.004


O
O
NH
O
N
H


12.07
0.47
0.85
1.00
1.06
1.08
1.11
10
8
6
4
2
0PPM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155.943
155.274
149.638
142.702
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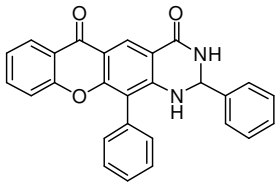
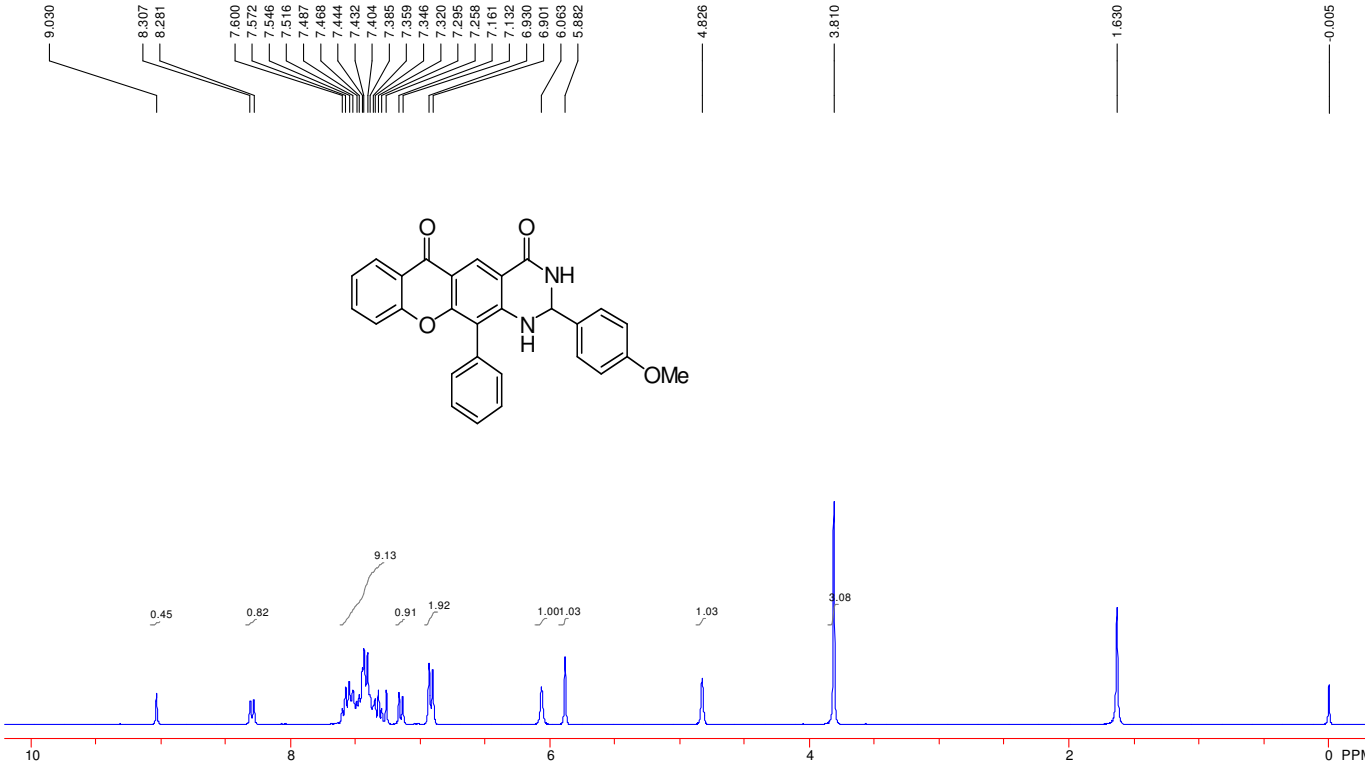
131.138
129.220
128.436
128.318
128.127
126.697
125.750
125.630
124.251
123.876
117.678
112.900
112.583
112.354
65.212
40.124
39.914
39.705
39.500
39.290
39.081
38.871


O
O
NH
O
N
H

180
160
140
120
100
80
60
40
20
ppm

4b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7.572
7.546
7.516
7.487
7.468
7.444
7.432
7.404
7.385
7.359
7.346
7.320
7.295
7.258
7.161
7.132
6.930
6.901
6.063
5.882
4.826
3.810
1.630
-0.005
O
O
NH
N
H
O
OMe
9.13
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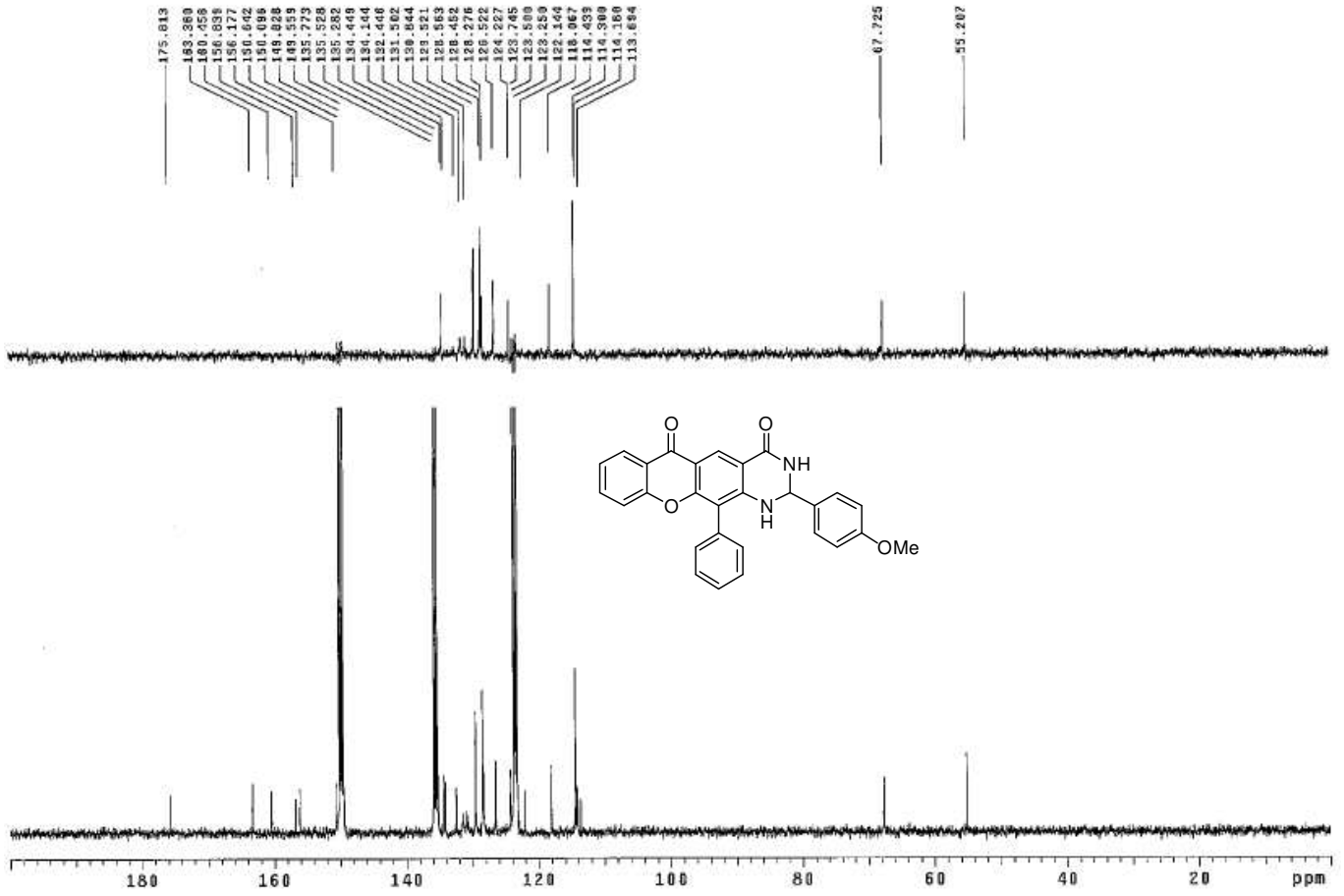
0.82
0.91
1.92
1.00
1.03
3.08
10
8
6
4
2
0 PPM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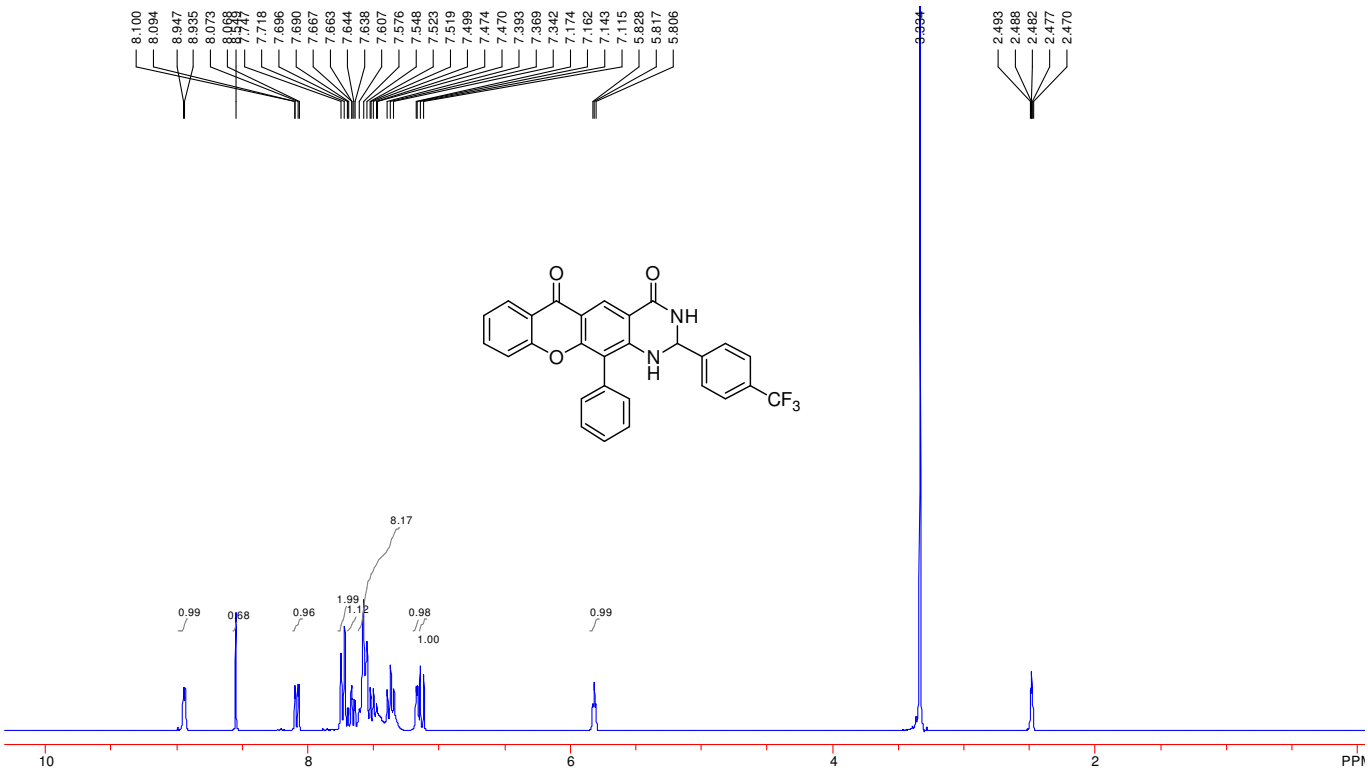
150.642
150.098
149.828
149.559
135.773
135.528
135.282
134.449
134.144
132.448
131.562
130.844
129.521
128.563
128.452
128.276
126.522
124.227
123.745
123.500
123.259
122.144
118.067
114.433
114.300
114.160
113.684
67.725
55.207
O
O
NH
N
H
O
OMe
180
160
140
120
100
80
60
40
20
ppm

4c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8.947
8.935
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7.747
7.718
7.696
7.690
7.667
7.663
7.644
7.638
7.607
7.576
7.548
7.523
7.519
7.499
7.474
7.470
7.393
7.369
7.342
7.174
7.162
7.143
7.115
5.828
5.817
5.806
3.334
2.493
2.488
2.482
2.477
2.470
O
O
NH
N
H
O
CF3
8.17
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1.99
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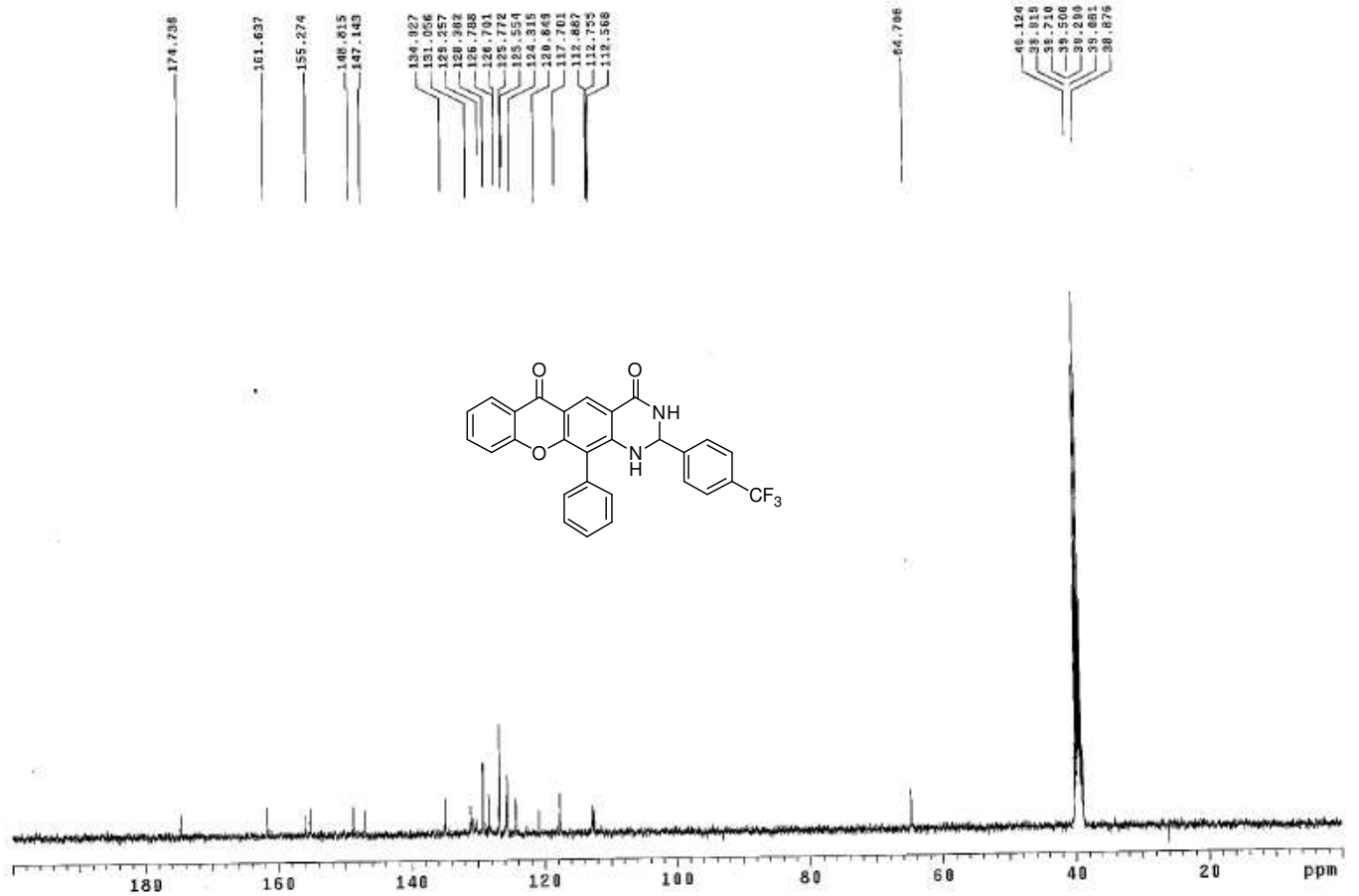
1.00
0.99
10
8
6
4
2
PPM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148.815
147.143
134.927
131.056
129.257
128.302
126.788
126.701
125.772
125.554
124.315
120.649
117.701
112.887
112.755
112.568
64.706
40.124
39.919
39.710
39.500
39.290
39.081
38.876
O
O
NH
N
H
O
CF3
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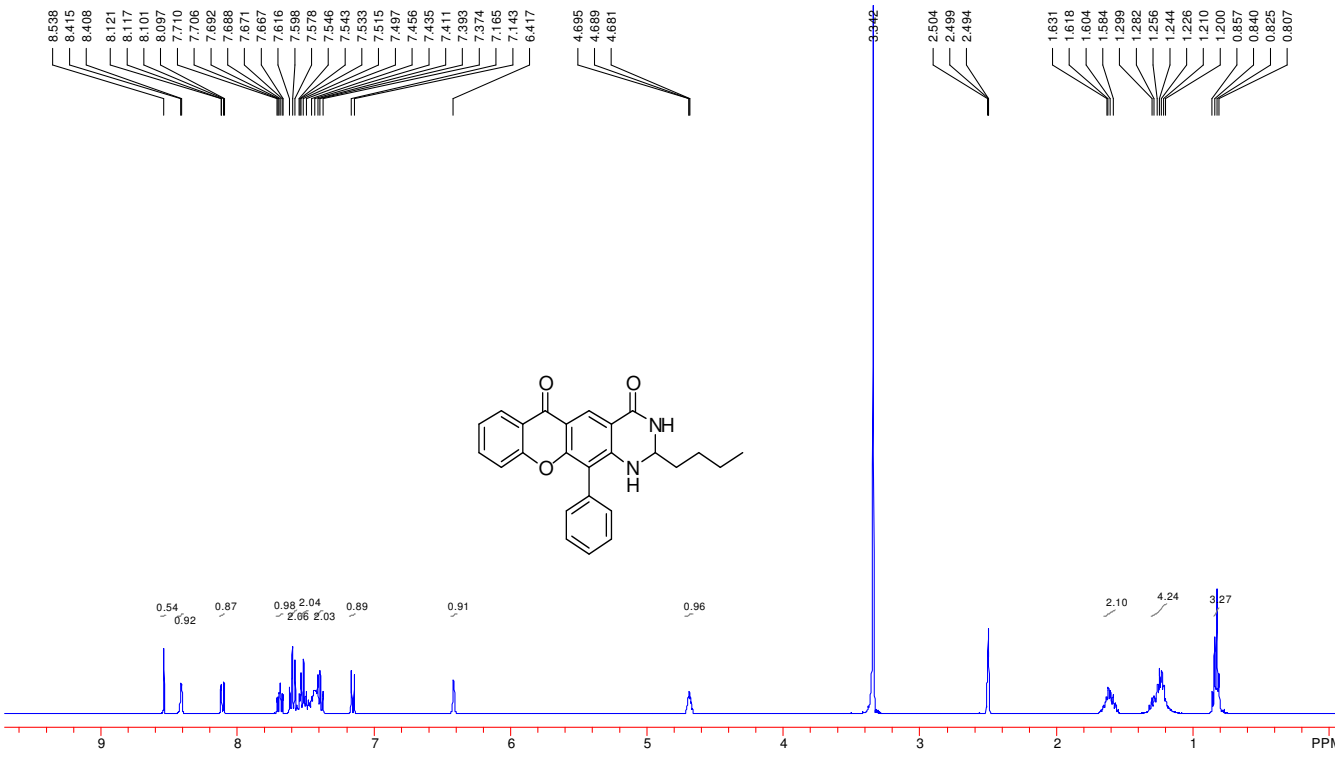
160
140
120
100
80
60
40
20
ppm

4d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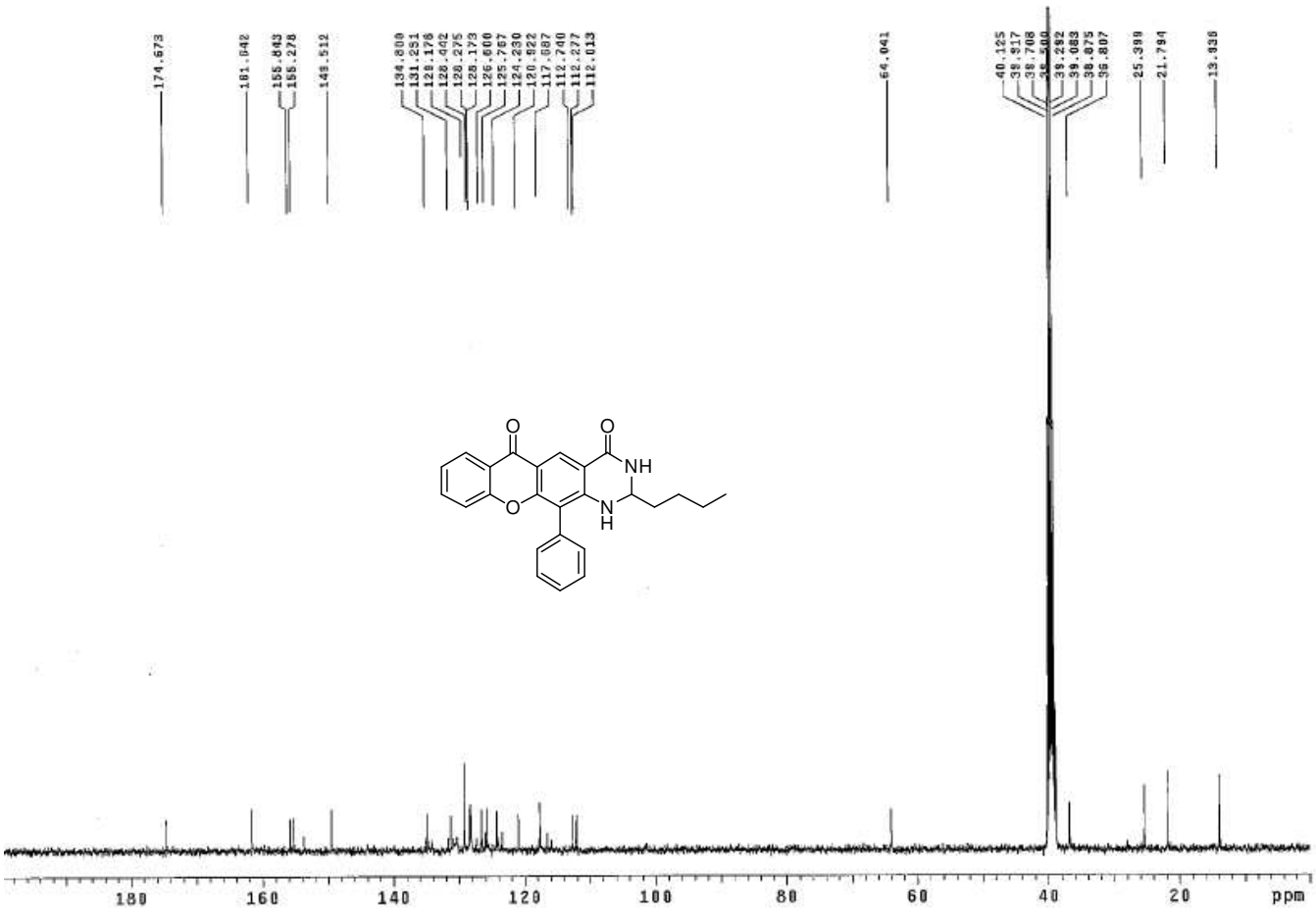
8.117
8.101
8.097
7.710
7.706
7.692
7.688
7.671
7.667
7.616
7.598
7.578
7.546
7.543
7.533
7.515
7.497
7.456
7.435
7.411
7.393
7.374
7.165
7.143
6.417
4.695
4.689
4.681
3.342
2.504
2.499
2.494
1.631
1.618
1.604
1.584
1.299
1.282
1.256
1.244
1.226
1.210
1.200
0.857
0.840
0.825
0.807
O
O
NH
N
H
0.54
0.92
0.87
0.98
2.04
2.06
2.03
0.89
0.91
0.96
2.10
4.24
3.27
9
8
7
6
5
4
3
2
1
PPM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155.278
143.512
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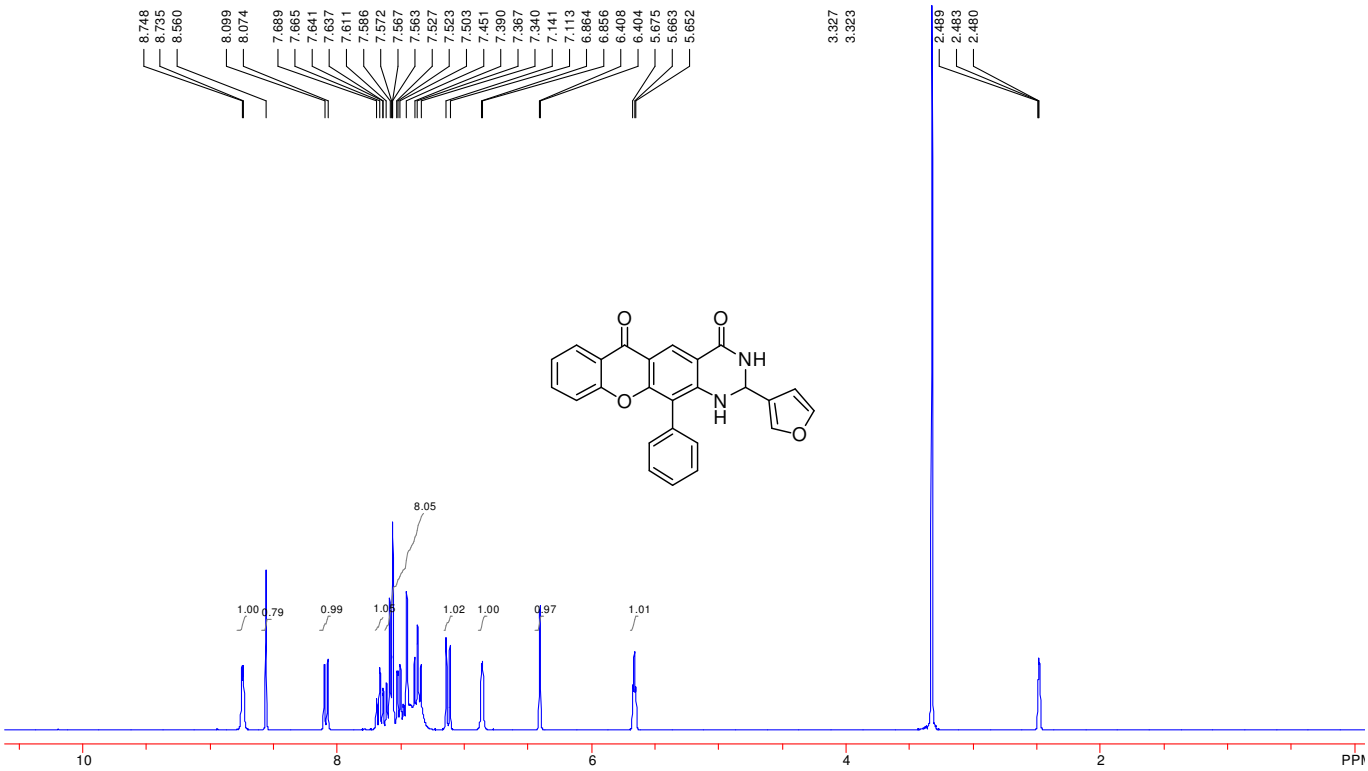
129.176
128.442
128.275
128.173
126.600
125.767
124.230
120.922
117.687
112.740
112.277
112.013
64.041
40.125
39.817
39.708
39.500
39.292
39.083
38.875
38.807
25.399
21.794
13.936
O
O
NH
N
H
180
160
140
120
100
80
60
40
20
ppm

4e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8.560
8.099
8.074
7.689
7.665
7.641
7.637
7.611
7.586
7.572
7.567
7.563
7.527
7.523
7.503
7.451
7.390
7.367
7.340
7.141
7.113
6.864
6.856
6.408
6.404
5.675
5.663
5.652
3.327
3.323
2.489
2.483
2.480
O
O
NH
N
H
O
8.05
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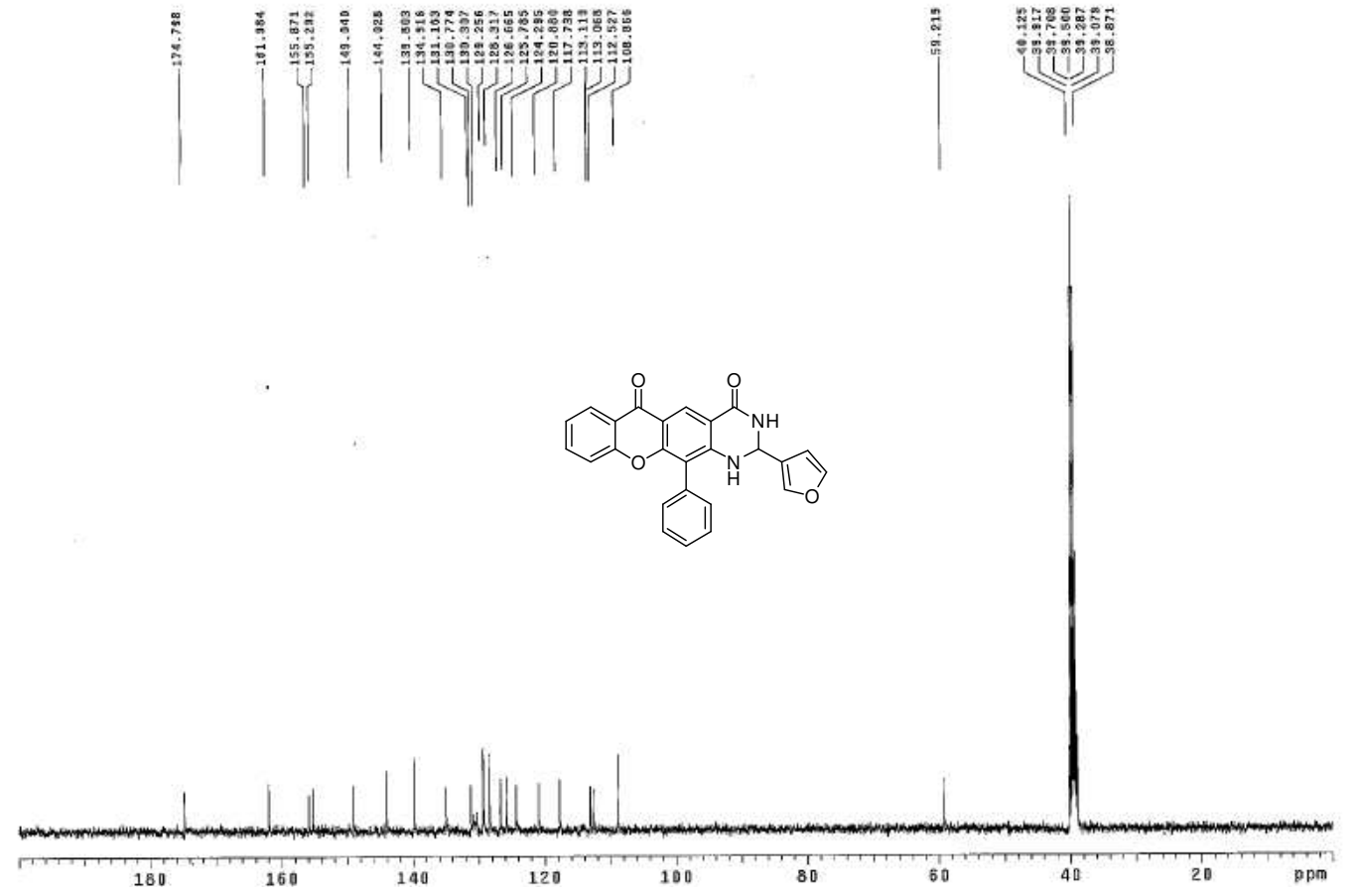
0.79
0.99
1.05
1.02
1.00
0.97
1.01
10
8
6
4
2
PPM


174.748
161.384
155.871
155.242
149.040
144.928
138.803
134.516
131.103
130.774
130.397
129.256
128.317
126.665
125.765
124.295
120.880
117.738
113.113
113.068
112.527
100.856
59.213
40.125
39.917
39.708
39.500
39.287
39.078
38.871
O
O
NH
N
H
O
180
160
140
120
100
80
60
40
20
ppm